IN THE UNITED STATES DISTRICT COURT
FOR THE SOUTHERN DISTRICT OF ILLINOIS

UNITED STATES OF AMERICA, Plaintiff, v. SCHLUMBERGER INDUSTRIES, INC. Defendant.	)	CIVIL ACTION NO. 91-4222-JLF

FIRST AMENDMENT TO CONSENT DECREE

FIRST AMENDMENT TO CONSENT DECREE

WHEREAS, on August 27, 1992, this Court entered a Consent Decree between the United States of America and Schlumberger Industries, Inc. (the "Parties") relating to the PCBs Operable Unit of the Crab Orchard National Wildlife Refuge located in Williamson, Jackson, Union, and Johnson Counties, Illinois (the "Facility");

Schlumberger Industries, Inc. was a wholly-owned subsidiary of Schlumberger Technology Corporation. On or around January 13, 1998, Schlumberger Industries, Inc. changed its name to Schlumberger Resource Management Services, Inc. On or about December 31, 2001, it changed its name again to SchlumbergerSema Inc. On January 29, 2004, Schlumberger Technology Corporation sold SchlumbergerSema Inc. to Atos Origin and assumed certain liabilities of SchlumbergerSema, Inc., including all liabilities and obligations relating to the Crab Orchard National Wildlife Refuge and Consent Decree;

In April 2011, the United States, Schlumberger Technology Corporation, and Atos Origin, as the successor to Schlumberger Industries, Inc., filed a Joint Motion to Substitute Party pursuant to Federal Rule of Civil Procedure 25(c), to substitute Schlumberger Technology Corporation for Schlumberger Industries, Inc. as the party in this action.

In 2007, the United States Environmental Protection Agency ("U.S. EPA") modified the selected remedy for chlorinated volatile organic compound contaminated groundwater for areas known as Plume 1 and Plume 3 at the PCBs Operable Unit. This decision is embodied in the Record of Decision Amendment dated May 2007 ("ROD Amendment"), signed on behalf of U.S. EPA on August 7, 2007 (see Attachment A), to which the United States Department of Interior ("U.S. DOI") and the State of Illinois gave their concurrence. The Parties hereby agree to incorporate the ROD Amendment into Appendix 1 of this Consent Decree;

The Parties have developed a Scope of Work to implement the ROD Amendment and hereby agree to the modification of Appendix 2 to incorporate the Scope of Work dated November 2010 (see Attachment B);

Pursuant to Section XXV of the Consent Decree, the Parties have agreed to this First Amendment to Consent Decree to incorporate the ROD Amendment and the related Scope of Work, and to provide for certain procedures and activities not previously contemplated by the Parties under the Consent Decree;

NOW, THEREFORE, it is hereby Ordered, Adjudged, and Decreed:

1. Except as specifically provided in this First Amendment to Consent Decree, all provisions of the original Consent Decree shall be in full force and effect.

2. All references to "Schlumberger Industries, Inc.," in the Consent Decree shall be deleted and replaced with the words "Schlumberger Technology Corporation."

3. Paragraph 4 of the Consent Decree is amended by revising the definition of "Consent Decree" to read as follows:

> "Consent Decree" or "Decree" means this Consent Decree and all Appendices attached hereto, as modified by the First Amendment to Consent Decree and all attachments thereto. In the event of conflict between the Decree and any Appendix, the Decree shall control.

4. Paragraph 4 of the Consent Decree is amended by revising the definition of "PCBs Operable Unit" by deleting the words "and heavy metals and includes the following four sites within the Facility" and replacing them with the following:

> heavy metals, and volatile organic compounds, and includes all soils, sediments, surface water, and groundwater at the following four sites within the Facility

5. Paragraph 4 of the Consent Decree is amended by adding the following definition:

> "Plume 1" means the groundwater plume extending from the Building I-1-23 source area, located within the PCBs Operable Unit, as described and addressed in Section VIII, subsection g. of the ROD Amendment.

6. Paragraph 4 of the Consent Decree is amended by adding the following definition:

> "Plume 2" means the groundwater plume near Buildings I-1-2 and I-1-3, located within the PCBs Operable Unit, as referenced in Section VIII, subsection g. of the ROD Amendment.

7. Paragraph 4 of the Consent Decree is amended by adding the following definition:

> "Plume 3" means the groundwater plume extending from beneath the Area 9 Repository, located within the PCBs Operable Unit, as described and addressed in Section VIII, subsection g. of the ROD Amendment.

8. Paragraph 4 of the Consent Decree is amended by adding the following definition:

"ROD Amendment" means the administrative Record of Decision Amendment dated May 2007 issued by U.S. EPA, amending the remedial actions for contaminated groundwater at the PCBs Operable Unit.

9. Paragraph 4 of the Consent Decree is amended by revising the definition of "Settling Defendant" by deleting the words "Schlumberger Industries, Inc." and replacing them with the words "Schlumberger Technology Corporation."

10. Paragraph 4 of the Consent Decree is amended by revising the definition of "Work" to add the phrase "the ROD Amendment" after the term "ROD."

11. Paragraph 5.b. of the Consent Decree is amended by adding the phrase "the ROD Amendment" after the term "ROD."

12. Paragraph 12 of the Consent Decree is amended by deleting the paragraph in its entirety and substituting the following:

a. The Work required by the ROD shall meet the Performance and Cleanup Standards set forth in Parts III and IV of the implementing SOW, and Sections VIII(A)(3) & (B) and X(B) of the ROD.

b. The Work required by the ROD Amendment shall meet the Performance and Cleanup Standards set forth in Parts III(B) and IV(B) of the implementing SOW and Section XIII of the ROD Amendment.

13. Paragraph 85 of the Consent Decree is amended by replacing the words "Remedial Action" with "Soil, Sediment, and Surface Water Work" in the paragraph title and throughout the body of the paragraph.

14. Paragraph 85 of the Consent Decree is amended by inserting the words "for Soil, Sediment, and Surface Water" after the words "Cleanup and Performance Standards" throughout the body of Paragraph 85.

15. Paragraph 85(b) of the Consent Decree is amended by replacing the last sentence with the following sentence: "U.S. EPA shall issue a Certification of Completion of Soil, Sediment, and Surface Water Work upon a determination that Settling Defendant has completed operation of the treatment systems and has fully constructed the containment system, and which

acknowledges that Settling Defendant has completed all work required by this Consent Decree, ROD, and related work plans, as they pertain to Soil, Sediment, and Surface Water."

16. A new Paragraph 86 is inserted in the Consent Decree that states the following:

86. Certification of Completion of Construction. After construction of the remedial action selected for Plume 1, 2 or 3 is completed, Settling Defendant shall follow the procedure in this Paragraph to obtain a Certification of Completion of Construction for each Plume. Settling Defendant may seek individual or combined Certificates of Completion for the Plumes 1, 2, and 3.

a. Application. When Settling Defendant believes that physical construction and installation of the remedial action selected for Plumes 1, 2, or 3 by the ROD Amendment (and any subsequent amendment regarding Plume 2) has been completed and the remedial action is operating properly and successfully, Settling Defendant shall submit to the U.S. EPA a Notification of Completion of Construction and a final report which summarizes the Work done and any modification made to the SOW or Work Plan(s). The report shall be prepared and certified as true and accurate by a registered professional engineer and the Settling Defendant's Project Coordinator, and shall include design specifications and drawings.

b. Certification. Upon receipt of the Notice of Completion of Construction, U.S EPA shall timely review the final report and supporting documentation, and the remedial actions taken. U.S. EPA shall issue a Certification of Completion of Construction upon a determination that Settling Defendant has completed all physical construction and installation of the remedy in accordance with the terms of the ROD Amendment, SOW, and Work Plan(s) for the groundwater plume at issue and the remedial action is operating properly and successfully.

c. Post-Certification Obligations. Following issuance of the Certification of Completion of Construction for Plume 1, Plume 2, or Plume 3, and pursuant to the terms and conditions set forth in Appendix 5 of this Consent Decree, U.S. DOI shall perform all maintenance, operation, and monitoring for

the respective plume, in accordance with Appendix 5 hereto, and as may be required under the Consent Decree, the SOW, the ROD Amendment, the Work Plan(s), or any other plans implemented pursuant to this Consent Decree.

17. A new Paragraph 87 is inserted in the Consent Decree that states the following:

87. Certification of Completion of Remedial Action.

a. Application. When Settling Defendant believes that the Remedial Actions for Plumes 1 and 3 and Plume 2 at the PCBs Operable Unit have been completed and the Cleanup and Performance Standards have been attained in accordance with this Consent Decree, it shall submit to the United States a Notification of Completion of Remedial Action and a final report which summarizes the Work done, any modification made to the SOW or Work Plan(s) thereunder relating to the Cleanup and Performance Standards, and data demonstrating that the Cleanup and Performance Standards have been achieved for groundwater. The report shall be prepared and certified as true and accurate by a registered professional engineer and the Settling Defendant's Project Coordinator, and shall include appropriate supporting documentation. Additionally, Settling Defendant must obtain a Certification of Completion of Soil, Sediment, and Surface Water Work, as provided for in Paragraph 85 of this Consent Decree, prior to submitting a Notification of Completion of Remedial Action.

b. Certification. Upon receipt of the Notice of Completion of Remedial Action, U.S. EPA shall timely review the final report and supporting documentation, and the remedial actions taken. U.S. EPA shall issue a Certification of Completion of Remedial Action upon a determination that operation of the remedies has been completed in accordance with the terms of this Consent Decree, and compliance with Cleanup and Performance Standards has been demonstrated.

c. Long-Term Operation, Maintenance and Monitoring. Following Certification of Completion of Remedial Action, U.S. DOI shall perform all operation, maintenance, and monitoring for groundwater as may be required

under the Consent Decree (including Appendix 5), the SOW, the ROD, the Work Plan(s), or any other plans implemented pursuant to this Consent Decree.

18. Paragraph 86 of the Consent Decree is renumbered Paragraph 88.

19. Attached to and incorporated into this First Amendment to Consent Decree are the following:

Attachment A: ROD Amendment (May 2007)

Attachment B: First Modification to Appendix 2, Scope of Work for Remedial Design/Remedial Action, PCB Areas Operable Unit, Crab Orchard National Wildlife Refuge, Carterville, Illinois (November 2010)

Attachment C: Appendix 5, Supplemental Agreement Between the U.S. Department of the Interior and Schlumberger Industries, Inc. Regarding the PCBs Operable Unit, Crab Orchard National Wildlife Refuge (November 2010)

20. The List of Appendices on page 69 of the Consent Decree shall be amended to add the First Amendment to Consent Decree and its attachments as Appendix 6. The attached ROD Amendment shall be deemed an addition to Appendix 1 of the Consent Decree. The attached First Modification of SOW shall be deemed an addition to Appendix 2 of the Consent Decree as provided in the definition of "Scope of Work" or "SOW" in Paragraph 4 of the Consent Decree. The attached Appendix 5 shall be deemed to wholly supersede and replace Appendix 5 of the Consent Decree.

21. This First Amendment to Consent Decree shall be lodged with the Court for a period of not less than 30 days for public notice and comment in accordance with Section 122(d)(2) of CERCLA, 42 U.S.C. § 9622(d)(2), and 28 C.F.R. § 50.7. The United States reserves the right to withdraw or withhold its consent if the comments regarding the First Amendment to Consent Decree disclose facts or considerations which indicate that the First Amendment to Consent Decree is inappropriate, improper, or inadequate.

22. If for any reason the Court should decline to approve this First Amendment to Consent Decree in the form presented, this First Amendment to Consent Decree is voidable at the sole discretion of either Party in writing within 30 days of the Court's action. If either Party elects to void the First Amendment to Consent Decree, the terms of the First Amendment to Consent Decree may not be used as evidence in any litigation between the Parties and the original Consent Decree shall remain fully in effect and enforceable.

23. The undersigned representative of the Settling Defendant to this First Amendment to Consent Decree and the Assistant Attorney General for the Environment and Natural Resources Division of the Department of Justice certifies that he or she is fully authorized to enter into the terms and conditions of this First Amendment to Consent Decree and to execute and legally bind such Party to this document.

SO ORDERED.

THE COURT'S APPROVAL AND ENTRY OF THIS CONSENT DECREE SHALL BE SIGNIFIED BY ENTRY OF A SEPARATE ORDER IN ACCORDANCE WITH THE COURT'S ELECTRONIC CASE FILING POLICIES AND PROCEDURES MANUAL

_____

_____
United States District Judge

THE UNDERSIGNED PARTY enters into this First Amendment to Consent Decree in the matter of United States v. Schlumberger Indus., Case No. 91-4222 (S.D. Ill.), relating to the PCBs Operable Unit of the Crab Orchard National Wildlife Refuge Superfund Site.

FOR THE UNITED STATES OF AMERICA

_____
Date

_____
IGNACIA S. MORENO
Assistant Attorney General
Environment and Natural Resources Division
U.S. Department of Justice
Washington, D.C. 20530

_____
Date

_____
JEFFREY A. SPECTOR
Environmental Enforcement Section
Environment and Natural Resources Division
U.S. Department of Justice
P.O. Box 7611
Washington, D.C. 20044-7611

THE UNDERSIGNED PARTY enters into this First Amendment to Consent Decree in the matter of United States v. Schlumberger Indus., Case No. 91-4222 (S.D. Ill.), relating to the PCBs Operable Unit of the Crab Orchard National Wildlife Refuge Superfund Site.

4-19-12
Date

RICHARD C. KARL
Superfund Division Director, Region 5
U.S. Environmental Protection Agency
77 West Jackson Blvd.
Chicago, IL 60604

THE UNDERSIGNED PARTY enters into this First Amendment to Consent Decree in the matter of United States v. Schlumberger Indus., Case No. 91-4222 (S.D. Ill.), relating to the PCBs Operable Unit of the Crab Orchard National Wildlife Refuge Superfund Site.

3/29/12
Date

LAURA B. BROWN
Associate Solicitor
U.S. Department of the Interior
Office of the Solicitor
1849 C Street, NW, MS #5530
Washington, D.C. 20240

3/29/12
Date

CASEY S. PADGETT
Assistant Solicitor
U.S. Department of the Interior
Office of the Solicitor
1849 C Street, NW, MS #5530
Washington, D.C. 20240

THE UNDERSIGNED PARTY enters into this First Amendment to Consent Decree in the matter of United States v. Schlumberger Indus., Case No. 91-4222 (S.D. Ill.), relating to the PCBs Operable Unit of the Crab Orchard National Wildlife Refuge Superfund Site.

FOR SCHLUMBERGER TECHNOLOGY CORPORATION

3/19/12
Date

Signature: Daniel Yates
Name (print): DANIEL YATES
Title: VICE PRESIDENT
Address: 300 SCHLUMBERGER DR.
SUGAR LAND, TX 77478

Agent Authorized to Accept Service on Behalf of Above-signed Party:

Name (print): _____
Title: _____
Address: _____
_____
_____
Ph. Number: _____

ATTACHMENT A

RECORD OF DECISION AMENDMENT
PCB AREAS OPERABLE UNIT
SANGAMO ELECTRIC DUMP/CRAB ORCHARD NATIONAL WILDLIFE REFUGE SUPERFUND SITE
CARTERVILLE, ILLINOIS

MAY 2007

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION V
CHICAGO, ILLINOIS

TABLE OF CONTENTS

Declaration for the Record of Decision Amendment
Crab Orchard National Wildlife Refuge
PCB Areas Operable Unit

A. SITE NAME AND LOCATION

Sangamo Electric Dump/Crab Orchard National Wildlife Refuge (US DOI)
Carterville, Illinois (EPA ID: IL8143609487)

B. STATEMENT OF BASIS AND PURPOSE

This decision document amends U.S. Environmental Protection Agency's (U.S. EPA's) selected remedial actions for contaminated groundwater at the PCB Areas Operable Unit (PCB OU) within the Sangamo Dump/Crab Orchard National Wildlife Refuge Superfund Site ("Site"), which were chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA), and to the extent practicable, the National Contingency Plan (NCP). This decision is based on the Administrative record for this Site. The State of Illinois concurs with the revised remedies identified in this amendment. This ROD Amendment will become part of the Administrative Record file to comply with NCP 300.825(a)(2).

C. ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response action selected in the August 1, 1990 Record of Decision (ROD) and the June 23, 2000 Explanation of Significant Differences (ESD) for the PCB OU, as modified by this ROD Amendment, may present an imminent and substantial endangerment to public health, welfare, or the environment.

D. DESCRIPTION OF THE SELECTED REMEDY

Overall Site Cleanup Strategy

The Crab Orchard National Wildlife Refuge (Refuge) is currently divided into seven Operable Units (OUs). These OUs are:

- Metals Areas (Metals) OU
- PCB Areas OU
- Explosives/Munitions Manufacturing Areas (EMMA) OU
- Miscellaneous Areas (MISCA) OU
- Water Towers OU
- Additional and Uncharacterized Sites (AUS) OU
- Lake Monitoring OU

The OUs are in various phases of cleanup: investigation, remediation, and long-term monitoring. Separate RODs were signed for the Metals OU, PCB OU, and the EMMA OU, on March 30,

1990, August 1, 1990, and February 19, 1997, respectively. A ROD for Site 14 of the MISCA OU was signed on October 30, 2001. Another ROD for Site 36 and other sites within the MISCA OU was signed on September 12, 2002. Separate Explanations of Significant Differences (ESD) were signed for the EMMA OU and the PCB OU on January 11, 2000 and June 23, 2000, respectively.

Remedial and Removal activities are complete for the Metals OU, EMMA OU, Water Towers OUs, and Site 36 of the MISCA OU. Long-term monitoring is being conducted for the Metals OU and the EMMA OU. A major portion of the PCB OU cleanup activities required under the 1990 ROD for the PCB OU was completed in 1997. Cleanup activities for Site 14 of the MISCA OU are in progress. The remedial investigation is in progress for the AUS OU. The Preliminary Screening Assessment for the Lake Monitoring OU was completed on October 9, 2001.

Addressing Principal Threats at the PCB OU

This ROD Amendment modifies the previously selected remedy for Chlorinated Volatile Organic Compound (CVOC) contaminated groundwater at the PCB OU within the Crab Orchard Site. This revision affects the cleanup technology selected in the June 23, 2000 ESD for the PCB OU. This ROD amendment does not affect the soils remedy and other requirements specified in the August 1, 1990 ROD for the PCB OU. The 2000 ESD specified multiphase extraction (MPE) with phytoremediation and monitored natural attenuation as the groundwater remedy to bring the groundwater to drinking water standards.

There are three major groundwater plumes at Sites 32/33 of the PCB OU, identified as follows:

1. **Groundwater Plume near Building I-1-23 (Plume 1)**

2. **Groundwater Plume near Buildings I-1-2/I-1-3 (Plume 2)**

3. **Groundwater Plume beneath the Area 9 Repository (Plume 3)**

This Amendment to the ROD and ESD focuses on Plumes 1 and 3 only. Although Plume 2 was discussed in the proposed plan, in response to safety concerns raised by the U.S. Department of the Interior (DOI), U.S. EPA will issue a separate ROD Amendment for Plume 2 after DOI's concerns have been satisfied.

The revised remedies include the source removal through excavation and off-site disposal, groundwater extraction and treatment, phytoremediation, and through natural attenuation processes. The source material identified as the principal threat is soil and groundwater contaminated with Trichloroethylene (TCE) and other CVOCs.

Major Components of the Revised Remedies

The major components of the revised remedies for Plumes 1 and 3 are:

1. **Plume 1 – Excavation and Off-site Disposal of CVOC-contaminated soil to 1 mg/kg CVOC contour in the Upper Clay unit, Groundwater Extraction and Treatment in the Sand unit beneath the Upper Clay, and Phytoremediation.**

2. **Plume 3 – Phytoremediation and Monitored Natural Attenuation.**

3. **Institutional Controls to prohibit the installation of potable water wells until the groundwater is restored to the drinking water standards.**

E. ROD AMENDMENT DATA CERTIFICATION CHECK LIST

The following information is included in the Decision Summary of the ROD Amendment. Additional information can be found in the Administrative Record file for this Site.

- Chemicals of concern (Section VIII (f)/Groundwater Contaminant Sources and Plumes/ page 15)
- Past and Current Site Risk (Section X/Page 19)
- Cleanup levels established for chemicals of concern (Section XI/Page 21)
- How source materials constituting principal threats are addressed (XV/Page 34)
- Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater. (Section IX/Page 19)
- Potential land and groundwater use that will be available at the site as result of the Selected remedies (Section XV/Page 34)
- Estimated capital, annual operation, and maintenance (O&M), and total present worth cost estimates, discount rate, and the number of years over which the remedy cost estimates are projected. (Table 1/Page 31; Table 2/Page 33)
- Key factors that led to this ROD Amendment (Section VI/Page 8)

F. STATUTORY DETERMINATIONS

The revised remedy is protective of human health and the environment, complies with Federal and State requirements that are applicable or relevant and appropriate to the remedial actions, is cost effective, and utilizes permanent solutions and alternate treatment technologies to the maximum extent practicable.

The revised remedy for Plume 1 also satisfies U.S. EPA's statutory preference for treatment as a principal element of the remedies and reduces toxicity, mobility, or volume of hazardous substances, pollutants, or contaminants as a principal element through treatment.

Because the remedies from the 1990 ROD and this ROD Amendment will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that do not allow for unlimited use and unrestricted exposure, statutory review will be conducted within five years

after initiation of the remedial action to ensure that the remedy is, or will be, protective of the human health and the environment.

James E. Cason

Associate Deputy Secretary
Department of the Interior

JUL 10 2007

Date

for Richard C. Karl, Director
Superfund Division
U.S. EPA Region 5

8/7/07

Date

Decision Summary
Record of Decision Amendment for the PCB Areas Operable Unit
Sangamo Electric Dump/Crab Orchard National Wildlife Refuge
Superfund Site (USDOI)
Carterville, Illinois

I. Site Name, Location, and Brief Description

The Sangamo Electric Dump/Crab Orchard National Wildlife Refuge (US DOI) Superfund Site ("Site") (EPA ID# IL8143609487) is located near Marion, Illinois, (Figure 1) primarily within Williamson County, extending into Jackson and Union Counties in Southern Illinois. The Crab Orchard National Wildlife Refuge (the Refuge) consists of approximately 43,500 acres of multiple-use land. The Refuge is used as wildlife refuge and also for recreational, agricultural, and industrial purposes. The Refuge is owned by the U.S. government and currently is administered by the U.S. Fish and Wildlife Service (FWS), a bureau of the Department of the Interior (DOI).

II. Site History and Contamination Problems at the PCB OU

While presently administered by FWS, the Department of Defense (DOD) administered the Refuge during the World War II era in the 1940s. During the DOD administration, portions of the Refuge were leased to industrial tenants, primarily for the purpose of munitions and explosives manufacturing. In 1947, the DOD transferred the Refuge to the DOI. Congress, in passing the law that created the Crab Orchard National Wildlife Refuge, mandated a continuing industrial presence on the Refuge property. While the principal industry at the Refuge was production of explosives, several other industries including Sangamo Weston, Inc., which manufactured PCB capacitors, moved into the Refuge to occupy many of the buildings formerly used by the wartime industries.

Beginning in the late 1970s, DOI, U.S. EPA, and Illinois EPA conducted site investigations that indicated the presence of PCBs, lead, and cadmium in soils within the eastern portions of the Refuge. The Crab Orchard National Wildlife Refuge site was proposed for the National Priorities List (NPL) in 1984 and finalized on the NPL in July 1987. In 1989, a Remedial Investigation/Feasibility Study (RI/FS) Report was completed by FWS and Sangamo Weston, Inc.

During the RI/FS, thirty-three different study sites within the Refuge were investigated. The RI concluded that four of the sites needed remediation because of the presence of PCBs, lead, and cadmium, and that three other sites needed remediation due to the presence of heavy metals such as lead, cadmium, and chromium. U.S. EPA grouped these study sites into two separate operable units, the Metals Areas OU and the PCB Areas OU. The Metals Areas OU included the three study sites which contained heavy metals contamination. The PCB OU included the remaining four study sites that were contaminated with PCBs, lead, and cadmium. These four sites are the Job Corps Landfill (Site17), the Water Tower Landfill (Site28), the Area 9 Landfill (Site 32), and the Area 9 Building Complex (Site 33). In August 1990, U.S. EPA issued a ROD that selected

the remedial action for the PCB OU. In May 1991, a Consent Decree was signed between U.S. EPA, DOI, and Schlumberger Industries Inc. (Schlumberger), a successor corporation to Sangamo Weston, Inc. Under the terms of the Consent Decree, Schlumberger agreed to perform the cleanup set out in the *PCB OU ROD.*

In September 1991, U.S. EPA entered into a Federal Facilities Agreement (FFA) with the Department of the Interior, Illinois EPA, and the Department of the Army (DA) (collectively referred to as the FFA Parties). The general purpose was to ensure that the environmental impacts associated with past and present activities at the Refuge were thoroughly investigated and appropriate remedial action taken as necessary to protect the public health, welfare and the environment. The FFA Parties have identified seven Operable Units including the PCB Areas Operable Unit that is the focus of this ROD Amendment. During the soil cleanup activities, groundwater monitoring conducted by Schlumberger at the PCB OU detected trichloroethylene (TCE) and other chlorinated solvents at levels above their respective drinking water standards. In June 2000, U.S. EPA issued an Explanation of Significant Differences (ESD) to address the TCE-contaminated groundwater at the PCB OU. This ROD Amendment describes the changes to the cleanup action required in the June 2000 ESD. The U.S. EPA is the lead agency for implementing the cleanup activities required at the PCB OU, including the activities required in the ROD, ESD, and this amendment for the PCB OU. U.S. Department of the Interior (US DOI) and the Illinois EPA are the support agencies at the PCB OU.

More information on the Site History and contamination problems at other operable units are provided in the March 30, 1990 ROD for the Metals OU, August 1990 ROD for the PCB OU, February 1997 ROD for the EMMA OU, October 2001 ROD for the MISCA OU – Site 14, and September 2002 ROD for the MISCA OU – Site 36.

III. Cleanup Remedy Selected in the Record of Decision (August 1990)

In the 1990 ROD for the Crab Orchard Site's PCB OU, the selected remedy included:

1) The excavation of contaminated soil and sediment;

2) Treatment of all excavated soil and sediment contaminated with PCBs in excess of established remediation goals using mobile incineration technology;

3) Stabilization/fixation of residues from incineration and non-incinerated soil and sediment contamination with metals (if determined to be RCRA hazardous because of the metals leachability) to render them non-hazardous;

4) On-site disposal of non-hazardous treated material and untreated residues exceeding the cleanup targets in a landfill meeting the requirements of RCRA Subtitle D and 35 Illinois Administrative Code Part 807;

5) Backfilling, placement of low-permeability caps and closure of areas where contamination is below the excavation criteria or from where contaminated soil and sediment have been excavated; and

6) Environmental monitoring and maintenance during and after remedial construction to ensure the effectiveness of the remedial action.

IV. Remediation Goals Specified in the Record of Decision (August 1990)

The ROD required the four sites to be remediated to the following cleanup levels:

Soil and Sediment Remediation Goals

lead to 450 mg/kg dry soil,
cadmium to 10 mg/kg dry soil,
PCBs in top one foot of soil to 1 mg/kg dry soil,
PCBs in soil below one foot depth to 25 mg/kg dry soil, and
PCBs in sediments to 0.5 mg/kg dry sediments.

The ROD also required that the risk from all of the chemical contaminants present in the soil and sediment above naturally occurring background levels established for the site not exceed an excess cancer risk of one in one million and not exceed concentrations determined to produce any non-cancer chronic health effects.

Groundwater Remediation Goals

Although the ROD, in a discussion of Site 33, Area 9 Building Complex, reported that TCE groundwater contamination was detected in one well at 906 ppb, the ROD did not require groundwater remediation per se. Nor did the ROD formally identify federal or any more stringent State applicable or relevant and appropriate requirements (ARARs) for the groundwater cleanup. Removal of the contaminated surface soils was expected to control the groundwater contamination. The ROD did not presume that the groundwater required treatment, however, the ROD required monitoring of the groundwater at each of the remediated sites during and after construction of the remedial action. The ROD stated that the purpose of the monitoring was to ensure that after completion of the remediation of the contaminated soils and sediments, the remaining risk from all of the contaminants in the groundwater (measured at the source of the contamination) above naturally occurring background levels did not exceed any excess cancer risk or any standard. The ROD also stated that

> "If, at any time, groundwater at the contaminated sites exceeds a 10^{-6} cumulative lifetime cancer risk, or Maximum Contaminant Levels (MCLs) for carcinogens, whichever is more stringent; and MCLs, Maximum Contaminant Level Goals (MCLGs), or a hazard index of 1.0 for noncarcinogens; whichever is more stringent, additional remedial work as determined by U.S. EPA, shall be performed."

Surface Water Remediation Goals

The ROD provides that the surface water in Area 9 will be monitored during and after construction of the remedial action. The results would be evaluated to ensure that after completion of the remedial action for the contaminated soils and sediments, the cumulative risk from all of the contaminants in surface water above naturally occurring background levels established for the site shall not exceed any non-cancer risk of one in one million (10^{-6}) and shall not exceed any non-cancer chronic health effects.

V. Explanation of Significant Differences (June 2000)

The groundwater monitoring activities conducted by Schlumberger, as part of the 1990 ROD requirement, indicated the presence of TCE and other chlorinated solvents at levels far exceeding their respective MCLs at Sites 32/33. Schlumberger conducted a groundwater investigation at Sites 32/33 in 1997 and 1998 and prepared a Groundwater Investigation (GWI) and Focused Feasibility Study Report (FFS) to address groundwater contamination. Although TCE contamination was known to exist at the time of the ROD, the GWI discovered levels of TCE in groundwater as high as 66,000 parts per billion (ppb) or over 10,000 times the MCL of 5 ppb listed in the Safe Drinking Water Act. In addition to the TCE contamination, other chlorinated volatile organic compounds (CVOCs) including tetrachloroethene (PCE), Dichloroethene (DCE), and vinyl chloride were also discovered at levels above their respective MCLs. The GWI identified five separate known and potential CVOC source areas and associated groundwater plumes within the remediated sites 32/33. The June 2000 ESD for the PCB OU selected multiphase extraction (MPE) with limited phytoremediation and monitored natural attenuation as the appropriate remedial technology that was premised on source material removal. The remedy selected in the ESD was based on the assumption that the hydro-geological strata was similar in all of the source areas requiring remediation.

VI. Basis for the ROD Amendment

Schlumberger conducted a Pre-Design investigation to further characterize the source areas at the PCB OU. The results of the investigation confirmed the presence of three major contamination plumes in the groundwater. These are the plume near the Building I-1-23 area (Plume 1), the plume near the Buildings I-1-2/I-1-3 areas (Plume 2), and the plume under the Area 9 Repository (Plume 3). The investigation concluded that the hydro-geological strata near the Building I-1-23 area consisted of approximately 15 feet of an Upper Sand unit in between an Upper Clay and a Lower Clay unit, whereas near the Buildings I-1-2/I-1-3 Areas, the Upper Sand unit between the Upper and Lower Clay units is either missing or discontinuous. The absence of the sand layer in the Buildings I-1-2/I-1-3 source area makes it difficult to achieve the remedial action objectives using the multiphase extraction technology selected in the June 2000 ESD without further enhancement. Therefore, amendment to the ROD/ESD is necessary. This amendment is limited to Plumes 1 and 3. Due to the need to resolve safety concerns during the cleanup of Plume 2, that plume will be addressed by a separate amendment to the 1990 ROD.

VII. Community Participation

Section 300.435(c)(2)(ii) of the National Oil and Hazardous Substance Pollution Contingency Plan requires public participation in the process of approving a proposed plan ROD amendment. A Proposed Plan for the groundwater remediation at Sites32/33 of the PCB OU at the Crab Orchard National Wildlife Refuge was made available to the public on April 5, 2006. Copies of the Proposed Plan fact sheet were sent to people on the Refuge CERCLA mailing list, and copies of the Proposed Plan, Groundwater Investigation Report, and Focused Feasibility Study Report were placed in the information repositories. The notice of public availability of the Proposed Plan and administrative record, and the notice of public meeting were published in the Southern Illinoisan, and the Marion Daily Republican, the two local newspapers of widest circulation, on April 3, 2006. A public comment period was held from April 5, 2006 to May 5, 2006. U.S. EPA together with the support agencies and partners, U.S. Department of the Interior/Fish and Wildlife Service and Illinois EPA held two separate public sessions on April 19, 2006 to explain its recommended cleanup plan. At this meeting, representatives from U.S. EPA, IEPA, DOI, and Schlumberger answered questions about the remedial alternatives presented in the Proposed Plan. No comments were made. No comments were received during the comment period other than a request to extend the comment period.

In response to a request at the meeting to extend the public comment period, later on followed by an email request, U.S. EPA extended the public comment period to May 19, 2006. U.S. EPA received five comments on the Proposed Plan. The responsiveness summary included in this ROD Amendment addresses these comments.

The Proposed Plan and other CERCLA-related documents for the PCB OU are available for public review at the following repositories:

U.S. Fish and Wildlife Service
Refuge Headquarters
8588 Route 148
Marion, IL 62959
(618) 997-03344, Ext. 361

Morris Library
Southern Illinois University – Carbondale
Carbondale, IL 62901
(618) 453-2818

This ROD Amendment is made part of the Administrative Record file which is located at the FWS Refuge Headquarters listed above.

VIII. Site Characteristics

a. Site Setting

The Crab Orchard National Wildlife Refuge is located in Southern Illinois, just south and west of the city of Marion. The Refuge consists of approximately 43,500 acres of land primarily within Williamson County, extending west and south into Jackson, Union, and Johnson Counties. Crab Orchard Lake is the largest of several lakes within the Refuge. The western portion of the Refuge around Crab Orchard Lake is open to public use for recreational purposes, while the eastern portion of the Refuge is a wildlife sanctuary that is closed to general public access. Land around the eastern portions of Crab Orchard Lake is also used for industrial purposes. The construction of Crab Orchard Lake was completed in 1940 as part of the Crab Orchard Project for Land Utilization. The dam that impounds the waters of Crab Orchard Creek and its tributaries, creating Crab Orchard Lake reservoir, is located at the extreme western end of the lake and has a spillway elevation of 405 feet M.S.L. Crab Orchard Lake is approximately 9 miles long and varies in width from approximately 1.5 miles in the west near the dam to approximately 0.5 mile in the eastern end. The resulting surface area of the lake is 6,965 acres with a watershed drainage area of 72,525 acre-feet. The average water depth varies over the area of Crab Orchard Lake from approximately 2 to 9 feet with a maximum depth of 30 feet. The majority of the northern boundary of the PCB OU area terminates at a bay on Crab Orchard Lake.

b. Site Geology:

(1) Unconsolidated Sediment

The site is underlain by Recent and Quaternary unconsolidated deposits ranging from 30 to 100 feet thick. The unconsolidated deposits consist of the following units, listed in order from the ground surface downward.

Upper Clay: The Upper Clay occurs from the ground surface to depths of approximately 25 feet bgs (below ground surface) beneath most of the site, but thins to approximately 15 feet in the north near Crab Orchard Lake. The Upper Clay consists of weakly bedded, mottled brown and gray silty clays and clayey silts, with occasional silty sand seams and lenses. Many boring logs indicate structure within the Upper Clay, including laminar bedding or alternating 2- to 3-inch beds of finer and coarser material within the clay and silt, especially in the lower half of the unit beneath the Area 9 Repository. Vertical to sub-vertical fractures have been observed throughout this unit. The calculated hydraulic conductivity of this unit is on the order of 10^{-4} to 10^{-6} cm/s (centimeter per second), which is consistent with a silt or loess. The general composition and structure of the Upper Clay indicates that it is a weathered loess deposit, possibly underlain in some locations by slackwater lake deposits.

Upper Sand: The Upper Sand occurs at elevations between approximately 380 feet and 400 feet above mean sea level (MSL) and varies in thickness from 1 to 2 feet in the southern part of the site to approximately 20 feet in the western part and 15 feet in the northwestern part. The Upper Sand is possibly absent in the southeastern and central portions of the site, where the Lower Clay

rises above approximately 400 feet MSL. Composition of the Upper Sand ranges from a clayey sand to a well-graded sand. In some locations, fine layering within the Upper Sand is noted in the boring logs, and there is a general coarsening downward sequence at most locations. This unit is consistent with either a glacio-lacustrine or a glacial outwash deposit.

Lower Clay: The Lower Clay occurs between elevations of approximately 340 feet MSL and 410 feet MSL, with the higher elevations in the southern and south-central portions of the site. The upper surface of the Lower Clay unit is eroded to form hills and valleys, with upper surface elevations varying from 380 feet to 410 feet MSL. This unit ranges in composition from a silty clay to a clayey silt and contains a trace to little fine sand and angular gravel. The gravel content includes fragments of weathered sandstone and coal. The Lower Clay has a very uniform color and texture with no depositional structures noted. Vertical to sub-vertical fracturing is common at the top of the Lower Clay. At some drilling locations, sandy interbedding was noted within the upper 20 feet of the Lower Clay. These sand lenses appear to be discontinuous and are not present beneath much of the site. The Lower Clay is representative of Illinoisan glacial till.

Lower Sand: The Lower Sand, where present, occurs immediately above the bedrock surface. The top of the Lower Sand occurs at approximately 340 to 350 feet MSL. This unit ranges from 10 to 20 feet thick in the northern portion of the site beneath Crab Orchard Lake to approximately 2 feet thick in the southwestern portion and is not present in the southern and southeastern portions where the bedrock surface rises above approximately 350 feet MSL. The Lower Sand is consistently logged as silty sand, and is consistent with a glacial outwash deposit.

(2) Site Bedrock

The bedrock surface below Williamson County consists of Pennsylvanian rocks. These rocks are predominantly weak shales, but include thin (less than 25 feet thick) limestones, sandstones, and coal beds. The Pennsylvanian rocks generally have low porosity and permeability and yield small amounts of water through interconnected pores, fractures, and joints.

Bedrock encountered during groundwater investigations at the PCB OU was described as gray fine-grained micaceous sandstone, and drilling logs indicate that it is competent and well cemented. The sandstone has been identified as a part of the Carbondale Formation.

Topographically, the top of the bedrock surface slopes to the north and west toward Crab Orchard Lake. Bedrock elevations range from approximately 400 feet MSL in the southern and southeastern portions of the site to approximately 320 to 340 feet MSL in the northern and western portions of the site, respectively.

(3) Geology in VOC Source Areas

Although the geology encountered at each individual VOC source area can generally be described as above, each source area has distinct geologic features, as summarized below.

Building I-1-2/I-1-3 Area

Bedrock is very shallow in this area, generally within 30 feet of the ground surface near Building I-1-2, sloping downward to the north, east, and west.

The Lower Sand unit does not exist in this area due to the shallow bedrock.

The Upper Sand unit does not exist in northern, western, and southern portions of this area. The Upper Sand pinches out against the Lower Clay where the Lower Clay rises above approximately 405 feet MSL

The easternmost extent of the Upper Sand unit at this VOC source area is near the western side of Building I-1-2, and the unit thickens to approximately 20 feet to the west near Highway 148.

Building I-1-23 Area

The Upper and Lower Sand units are both present in this area. Bedrock occurs at approximately 100 feet bgs.

The upper surface of the Lower Clay unit appears to have an incised channel running from south to north through the source area.

The Upper Sand varies in thickness from 7 feet on the edges of the channel in the Lower Clay to nearly 20 feet in the center. The Upper Sand also appears to thin to the south of the Building I-1-23 Area.

Area 9 Repository

The Repository fill material ranges in thickness up to approximately 35 feet and is underlain by the Upper Clay unit.

Bedrock occurs at approximately 100 feet below original ground surface beneath the Repository.

The Upper Sand unit is not present beneath the Area 9 Repository.

The lower portions of the Upper Clay unit at the Repository indicate lacustrine features such as finely banded silts and clays, varves, and occasional sandy lenses.

Building I-1-36A Area

The Upper Sand unit is present beneath the entire Building I-1-36A area, and ranges in thickness from 8 to 18 feet.

The Upper Sand unit appears to thin slightly to the north.

South of Area 9 Repository

The Upper Sand unit appears to be continuous beginning approximately 250 feet south of the Repository and continuing to the south, and is not continuous to the north toward the Repository.

The Upper Sand unit thins to the west.

The Lower Clay surface rises in elevation from south to north to approximately 390 feet MSL in the north.

Lacustrine features are common in the lower portion of the Upper Clay unit in this location.

c. Groundwater Flow:

(1) Regional Hydrogeology

Regionally, the shallowest groundwater occurs within the unconsolidated glacio-lacustrine deposits that mantle the bedrock surface throughout much of Southern Illinois. Groundwater is often encountered within 20 feet of the ground surface. Shallow groundwater contours are a subdued reflection of the ground surface topography, with groundwater flowing from areas of high ground surface elevation to discharge areas at lower elevations, such as streambeds or lakes.

Water-bearing sand and gravel units within the glacial and lacustrine deposits of Southern Illinois are common but are generally thin. Groundwater yields from these units are not adequate for municipal supplies. In areas within the vicinity of the site, some thin scattered sand and gravel deposits provide adequate yield for farm and domestic water supplies.

The water-yielding characteristics of the Pennsylvanian bedrock are highly variable. In Williamson County, sandstone aquifer yields are adequate for domestic supplies throughout most of the county. The groundwater in these rocks becomes highly mineralized with depth, and production wells are rarely installed more than 200 to 300 feet into the bedrock. Domestic supplies from the sandstone aquifers are easily obtained at depths ranging from 50 to 80 feet.

(2) Groundwater Occurrence and Flow at the PCB OU

Generally, the groundwater table at the site is a subdued reflection of the topography, with flow northward toward Crab Orchard Lake. Groundwater flow within the clay units has a significant downward component, except in locations of groundwater discharge near surface water, while flow within the sand units is predominantly horizontal.

Upper Sand/Upper Clay

Groundwater is generally encountered from 1 foot to 15 feet bgs in the Upper Clay unit at the site. The one exception is beneath the Area 9 Repository, where groundwater occurs approximately 21 to 25 feet below the top of the Repository (approximately 1 to 5 feet below the

original pre-Repository ground surface elevation). Groundwater elevations at most monitoring well locations fluctuate approximately 3 to 8 feet during the year.

Shallow groundwater beneath the site generally flows northward toward Crab Orchard Lake but is affected locally by surface water drainage ways and by the Area 9 Repository. In the Building I-1-2 area, shallow groundwater flows radially away from a local groundwater high. A majority of the groundwater flow from this area is easterly, toward the East Swale, and westerly, toward the Heron Flats impoundment area located west of Highway 148. Horizontal hydraulic gradients in the Building I-1-2 area range from 0.003 to 0.006.

In the Building I-1-23 area, groundwater flows primarily northward toward Crab Orchard Lake, with a lesser component of flow to the northeast toward the Area 9 Repository. A groundwater mound is present beneath the Area 9 Repository. This causes shallow groundwater to flow to the east toward the Center Swale (located immediately adjacent to the Repository) and to the north toward Crab Orchard Lake. Horizontal hydraulic gradients in the Building I-1-23 area range from 0.004 to 0.006. Horizontal hydraulic gradients at the Area 9 Repository range from 0.01 to 0.02.

Lower Sand Unit

Groundwater in the Lower Sand unit flows to the north toward Crab Orchard Lake. The horizontal hydraulic gradient in the Lower Sand ranges from 0.0004 to 0.0005.

Over most of the site, the piezometric head in the Lower Sand is generally 1 to 3 feet lower than the head in the Upper Sand, indicating a downward potential. However, near Crab Orchard Lake, this is reversed, indicating an upward potential as groundwater discharges to the lake.

Groundwater Hydraulic Characteristics

In the Upper Clay, the calculated hydraulic conductivities range from 1.4×10^{-6} to 7.7×10^{-4} cm/s, with a geometric mean of 4.6×10^{-5} cm/s. These conductivity values are consistent with values reported for silt and loess of 10^{-7} to 10^{-3}cm/s.

In the Upper Sand, the calculated hydraulic conductivities range from 1.3×10^{-5} cm/s to 4.4×10^{-3} cm/s, with a geometric mean of 3.0×10^{-4} cm/s. These conductivity values are consistent with values reported for a silty sand or fine sand.

Hydraulic tests of sand seams within the Lower Clay showed consistent hydraulic conductivity values on the order of 10^{-6} cm/s. The calculated hydraulic conductivity for these sand lenses is an order of magnitude below the range expected for a silty sand and is generally more consistent with that of a glacial till.

In the Lower Sand, calculated hydraulic conductivities generally range from 9.4×10^{-4} to 4.1×10^{-3} cm/s, with a geometric mean of 1.9×10^{-3} cm/s. These values fall within the observed range for a silty sand of 10^{-5} to 10^{-2} cm/s documented in literature.

Vertical Flow

Vertical gradients are downward over most of the site, including at each of the identified VOC source areas. However, upward gradients are present near Crab Orchard Lake, where groundwater discharge to the lake is occurring. There are also vertical upward gradients immediately below and adjacent to the lower reaches of the swales and intermittent streams (where the swales and streams approach larger surface water bodies), where groundwater is discharging to surface water. One exception is the area downgradient to the west of Building I-1-2. At this location, there is still a downward component of groundwater flow, which suggests that the discharge area is still further to the west, near Heron Flats, on the western side of Highway 148.

d. Surface Water:

Surface water drainageways are present at several locations at the site. In the southwestern portion of the site, an intermittent stream that appears to originate near Buildings I-1-2/I-1-3 flows westerly toward Highway 148, passes beneath Highway 148 through a culvert pipe, and discharges into the Heron Flats impoundment area on the western side of the highway. The Center Swale originates on the eastern side of the main building complex and runs northeasterly along the eastern and southern sides of the Area 9 Repository before discharging to Crab Orchard Lake. The West Swale runs northward from the vicinity of Building I-1-23 and discharges to Crab Orchard Lake. The East Swale runs northward along the entire eastern boundary of the site and discharges to Crab Orchard Lake. The swales and the intermittent stream are often dry in their upper reaches, except following rainfall events. The lower reaches appear to be receiving groundwater inflow and are flowing over much of the year.

e. Groundwater/Surface Water Relationship:

Although often there is no standing or flowing water in the surface water drainageways at the site, the sediment in the lower reaches of the swales is often moist. This may indicate that groundwater is discharging to the lower reaches of the swales but at a rate that will not result in flowing water. It appears that the lower reaches of the swales and the intermittent stream are zones of groundwater discharge during most, if not all, of the year.

f. Groundwater Contaminant Sources and Plumes:

Volatile organic compounds, particularly PCE; TCE; cis-1,2-DCE; and vinyl chloride, make up the majority of the constituents detected in groundwater. Petroleum-related VOCs (e.g., benzene and toluene) have also been detected sporadically across the site. In addition, several less soluble chlorinated organic compounds (trichlorobenzene and dichlorobenzene) have been detected in groundwater samples from the VOC source areas near Buildings I-1-2 and I-1-23, and in the vicinity of Building I-1-36A.

VOC plumes within the Upper Sand unit extend from 500 feet to over 1,000 feet downgradient from each of the primary source areas. The distribution of VOCs in the groundwater plumes at the site is controlled largely by the hydraulic gradients in the shallow flow system; however, the

transport of VOCs from the source areas is also dependent on the geology. In areas where the Upper Sand unit is not present or is discontinuous, VOCs have been transported shorter distances than in areas where the Upper Sand is continuous.

The contaminants in groundwater are dominated by chlorinated solvents, especially TCE, DCE, and PCE. Of these contaminants, TCE is present at the highest concentrations over most of the site. Contaminants occur mainly within the Upper Clay and Upper Sand units; groundwater within the underlying Lower Clay and Lower Sand units generally shows nondetectable concentrations. The conceptual model for transport of contaminants at the site is that VOC source residuals are slowly releasing dissolved VOCs into the groundwater; the dissolved VOCs then migrate vertically downward from the source units (which are predominantly within the Upper Clay) through the Upper Clay into the Upper Sand unit. The high permeability of the Upper Sand unit relative to the Lower Clay unit results in groundwater flow that is primarily horizontal. Although there is a significant downward gradient from the Upper Sand to the Lower Sand over much of the site, the low permeability of the Lower Clay confining unit restricts the downward flow of groundwater and contaminants to the Lower Sand unit.

The permeable Upper Sand unit is the primary pathway for lateral contaminant migration in groundwater at the site. TCE and related compounds occur in groundwater plumes that extend up to 1,000 feet or more from the source areas in the Upper Sand unit. The general absence of contaminants in the Lower Sand unit indicates that, despite the existence of relatively strong downward gradients over portions of the site, contaminants have not reached the Lower Sand. Investigation data indicate that natural attenuation processes likely are responsible for limiting the migration of contaminants into the Lower Clay and the Lower Sand units.

g. Descriptions of Individual Plumes

Buildings I-1-2/I-1-3

Based on the soil chemistry data, there appear to be two separate, but nearby, VOC source areas in the Building I-1-2 area. One source area is located directly east of Building I-1-2, just south of the former location of a manufacturing building. The second source is located just east of Building I-1-3, north of the former building. The two source areas, although separate, form one plume to the east and one plume to the west of the combined Buildings I-1-2/I-1-3 area.

These two plumes of VOCs extend downgradient to the east and west of the Buildings I-1-2/I-1-3 source areas. The orientations of these plumes are consistent with the groundwater flow pattern in the area. Transport of contaminants to the north and south appears to be very limited in extent. A groundwater divide effectively splits the groundwater flow at the source areas to the east and west. In addition, the Upper Sand unit appears to be absent to the north and to the east of Buildings I-1-2/I-1-3. This also contributes to the limited groundwater flow from the Buildings I-1-2/I-1-3 source areas to the north or south.

The primary VOC constituents detected in groundwater wells nearest to the Building I-1-2 source area are TCE and DCE. However, a tentatively identified compound (TIC), 1,1,2-trichloro-1,2,2-trifluoroethane (Freon113), has also been detected in groundwater in this source

area. In addition, historical data indicate the presence of significant concentrations (on the order of 10 to 100 ppb) of trichloro-, dichloro-, and monochloro-benzenes. These compounds have low water solubility (19 ppm to 500 ppm) compared to TCE (1,100 ppm) and DCE (6,400 ppm), and are generally restricted to the immediate source area.

Investigation data indicate the importance of the Upper Clay as the primary source of VOCs leaching downward into the Upper Sand unit in this area, although the Upper Sand is not present throughout this source area. Downgradient to the west, groundwater within the Upper Clay contains low to nondetectable VOC concentrations, while groundwater from the Upper Sand in the same location contains significant VOC concentrations. The data indicate that, while the highest VOC concentrations occur within the shallow fine-grained sediment (Upper Clay) in the source area, lateral transport of VOCs occurs primarily within the Upper Sand, and downgradient areas of the Upper Clay are not impacted.

The VOC plume to the west of Building I-1-2 is of a greater extent, and contains higher VOC concentrations, than the plume to the east. The difference in VOC distribution is explained by the geology in this local area. The Upper Sand thickens to the west, which allows significant transport of contaminants, but appears to be discontinuous to the east, which limits lateral transport in that direction. As a result, the VOC plume to the east extends only approximately 800 feet downgradient toward the East Swale, while to the west total VOC concentrations on the order of 2,000 ppb persist more than 1,300 feet downgradient of the source area. Transport of VOCs to the west is toward the intermittent stream and low-lying area on the east side of Highway 148. However, no significant concentrations of VOCs have been detected in groundwater at the low-lying area near the highway.

Building I-1-23

Concentrations of VOCs on the order of 3,000 ppb extend in the groundwater plume from the Building I-1-23 source area northward (downgradient) to Crab Orchard Lake. Similar to the Building I-1-2 source area, the primary VOC constituents detected in groundwater nearest to this source area are PCE, TCE, and DCE; however, significant concentrations of chlorobenzene, and much lower concentrations of trichlorobenzene, have also been detected at the Building I-1-23 source area. As in the Building I-1-2 plume, trichloro- and monochloro-benzenes have not been detected in the plume originating at the Building I-1-23 area.

The vertical distribution of VOCs within the Building I-1-23 source area saturated zone is very similar to that observed in the Building I-1-2 source area. Shallow groundwater within the Upper Clay unit shows total VOC concentrations one order of magnitude higher than the groundwater at the same location within the Upper Sand. Unlike the Building I-1-2 area, however, total VOC concentrations in the Upper Sand and the Upper Clay in the groundwater near Crab Orchard Lake are very similar. This is the result of upward vertical gradients in the immediate vicinity of Crab Orchard Lake that cause upward movement of impacted groundwater from the Upper Sand, through the Upper Clay, and discharge to the West Swale and to Crab Orchard Lake.

Area 9 Repository

A plume of VOCs extends eastward from beneath the Area 9 Repository toward the Center and East Swales, and some migration of VOCs has occurred to the north toward Crab Orchard Lake. The distribution of contaminants emanating from soil beneath the Area 9 Repository is explained by the local water table configurations and by the geology. A groundwater mound is present beneath the Repository during much of the year, causing groundwater to flow both to the north toward Crab Orchard Lake and to the east toward the Center and East Swales. The thin and clay-rich nature of the Upper Sand beneath the Repository greatly reduces (by adsorption) the transport of VOCs away from the source area, particularly to the north where the deposit becomes very clayey. The transport of VOCs that does occur is primarily to the east, where the Upper Sand is thicker and of lower clay content. Therefore, it is believed that the Area 9 Repository plume discharges to the Center and East Swales.

The primary VOC constituents detected include PCE, TCE, and DCE. Few to no trichloro-, dichloro-, or monochloro-benzenes have been detected in groundwater at the Area 9 Repository. Concentrations of PCE and its degradation products are highest within the source area. TCE, DCE, and vinyl chloride are transported downgradient of the source area, but unlike the VOC plumes from the other source areas at the site, the concentrations of these compounds generally decrease in downgradient locations. The decrease of biodegradation products in the downgradient areas of the plume is the result of relatively low groundwater flow velocities in the vicinity of the Area 9 Repository. Low flow velocity limits the transport of PCE source material downgradient, thus reducing concentrations of biodegradation products in these areas.

Only low to non-detected concentrations of VOCs have been detected in the Upper Sand to the northeast of the Area 9 Repository. Variations in groundwater chemistry at this location appear to be the result of variations in the groundwater flow direction and possibly seasonal water table fluctuations. No VOCs have been detected in the Upper Sand east of the East Swale, and only a trace of TCE has been detected at the water table well at the same location. The groundwater chemistry data, in addition to the upward hydraulic gradients, indicate that groundwater flowing east from the Area 9 Repository is discharging to the East Swale. No significant groundwater contamination extends east of the East Swale.

Building I-1-36A

The primary VOC constituents detected in groundwater in the vicinity of Building I-1-36A are PCE, TCE, and DCE. Low concentrations of several dichlorobenzene compounds have also been detected. VOCs in groundwater in the area of Building I-1-36A form a plume, which extends first easterly toward the Center Swale, where it merges with a plume originating south of the Area 9 Repository, and then north and eastward toward the East Swale and Crab Orchard Lake. Here, the VOC plume from the direction of BuildingI-1-36A merges with the Area 9 Repository plume to the east of the Repository. Eastward transport of VOCs from the area of Building I-1-36A is aided by intermittent recharge from the Center Swale. Near Building I-1-36A, there is also a northerly component to the flow system that causes low VOC concentrations at the perimeter of the Building I-1-36A plume to merge with the Building I-1-23 plume. The western extent of VOC concentrations in groundwater in the area upgradient of

Building I-1-36A is uncertain; however, the presence of low concentrations of dichlorobenzenes in the shallow groundwater on the western side of BuildingI-1-36A suggests that the source area is nearby.

South Side, Area 9 Repository

A plume, designated the South Side plume, appears to originate from a separate source area located to the south of the Area 9 Repository and to the east of the Center Swale.

The primary VOC constituents within this plume are PCE, TCE, and DCE, similar to the other site source areas. Unlike the other source areas, trichloro-, dichloro-, and monochloro-benzenes were not detected in the groundwater samples. However, carbon tetrachloride (CTET) was detected within the Upper Sand unit. Like the chlorobenzene compounds, CTET is relatively insoluble in water. Its presence in groundwater at these locations and its absence elsewhere at the site indicates that this plume has a separate source area located near the southern side of the Area 9 Repository.

The South Side plume merges with the Building I-1-36A plume (from the west) and extends to the northeast toward the eastern side of the Area 9 Repository, following the trend of the Center Swale. Here it merges with the Area 9 Repository plume. The combined VOC plume is then transported to the east and north, where it emerges as surface water in the East Swale, which then flows into Crab Orchard Lake.

IX. Current and Future Site and Resource Uses

The Crab Orchard National Wildlife Refuge consists of approximately 43,500 acres of multiple use land. The refuge is used as wildlife refuge and also for recreational, agricultural, and industrial purposes. The Area 9 Landfill (Site 32) and the Area 9 Building Complex (Site 33) are located in an industrial area. Access is limited to employees working in the Area 9 Building complex and to refuge personnel. This area is expected to remain as an industrial area in the foreseeable future. The groundwater contamination emanating from the sites, however, extends beyond the designated industrial area in to the Crab Orchard Lake, which is a recreational area.

EPA generally defers to State Groundwater Classifications for current or future groundwater uses. Although the groundwater is not used currently for drinking water purposes, the contaminated aquifer at Sites 32/33 has been classified by the State of Illinois as a Class I Potable Resource Groundwater in accordance with Illinois Administrative Code, Title 35, Part 620, Subpart B (Section 620.210). Accordingly, Illinois EPA and U.S. EPA affirm the need to protect the potential future beneficial use of the Sites 32/33 Class I Potable Resource Groundwater by virtue of the remedies contained in this ROD Amendment.

X. Past and Current Site Risks

PCBs, lead, and cadmium were the contaminants of concern at four sites (Job Corps Landfill, Water Tower Landfill, Area 9 Landfill, and Area 9 Building Complex) within the PCB OU. These contaminants posed an unacceptable risk to human health and the environment, including

wildlife at the refuge. The 1990 ROD for the PCB OU describes in detail the site risks due to the contaminants of concern for each of these sites. The ROD also established remediation goals for soil, sediment, groundwater, and surface water, and required that following remediation, a risk assessment be conducted as noted below:

> Soil and Sediment: Risk assessment to ensure that the risk from all of the chemical contaminants present above naturally occurring background levels established for the Site in the soil and sediment shall not exceed an excess cancer risk of one in one million (10^{-6}) and shall not exceed concentrations determined to produce any non-cancer chronic health effects.
>
> Groundwater: Risk assessment to ensure that the risk from all of the contaminants in the groundwater (measured at the source of contamination) above naturally occurring background levels shall not exceed any excess human health risk or any standard. If at any time, groundwater at any of the remediated sites exceeds a 10^{-6} cumulative life-time cancer risk, or maximum contaminant levels (MCLs) for carcinogens, whichever is more stringent; and MCLs, maximum contaminant level goals (MCLGs), or a hazard index of 1.0; whichever is more stringent, for non-carcinogens, additional remedial work as determined by U.S. EPA shall be performed.
>
> Surface Water at Area 9: Risk assessment to ensure that the cumulative risk from all of the contaminants in the surface water above naturally occurring background levels established for the site in the soil and sediment shall not exceed an excess cancer risk of one in one million (10^{-6}) and shall not exceed any non-cancer chronic health effects.

Under the terms of the May 1991 Consent Decree, Schlumberger undertook the cleanup activities at these sites. In 1997, approximately 117,145 tons of PCB-contaminated soils were incinerated in an on-site mobile incinerator. PCB-contaminated soil/sediments with levels less than 25 mg/kg were consolidated and backfilled in an on-site repository at Site 32. Lead and cadmium contaminated soil were rendered non-hazardous, and disposed of in an on-site landfill at the refuge. Monitoring activities conducted by Schlumberger following the remedial action indicated the presence of TCE and other chlorinated solvents in the groundwater at Sites 32/33 at levels significantly higher than their respective MCLs. Groundwater at this site is State of Illinois Class I Potable Groundwater Resource and is contaminated with TCE and other chlorinated solvents well above MCLs and Illinois Class I Groundwater Standards. Currently, there is no risk to human health, because presently the groundwater is not being used for drinking water. Future use of the groundwater at Sites 32/33 as a drinking water resource would pose unacceptable risk, however.

Periodic air monitoring inside nearby buildings currently used by General Dynamics Ordnance and Tactical Systems (GDOTS) and indoor air samples collected by Schlumberger at Buildings I-1-2, I-1-3, and I-1-23 have shown that concentrations of VOCs inside these buildings are well within permissible environmental exposure standards adopted by Occupational Safety and Health Standards (OSHA). Implementation of the selected remedies would help mitigate any potential long-term risk to the building occupants due to soil vapor intrusion of TCE and other chemicals of concern from soil vapor intrusion. After completion of the remedial activities identified in

this ROD Amendment, a site-specific risk assessment will be conducted to ensure that all other requirements in the 1990 ROD are met.

Chemicals of concern for this ROD Amendment are Trichloroethylene (TCE), Tetrachloroethene (PCE), Dichloroethene (DCE), Vinyl chloride, and any other chlorinated volatile organic compounds which are found in groundwater above their respective MCLs. The highest reported TCE concentration in groundwater is 66,000 ppb. Highest reported TCE concentration in soil is 44 mg/kg.

XI. Remedial Action Objectives

40 CFR 300.430(a)(1)(iii)(F) of the National Contingency Plan (NCP) states:

> "EPA expects to return usable ground waters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site. When restoration of ground water to beneficial uses is not practicable, EPA expects to prevent further migration of the plume, prevent exposure to the contaminated groundwater, and evaluate further risk reduction."

The Remedial Action Objectives are as follows:

- Restore contaminated groundwater at Sites 32/33 to Drinking Water Standards to the extent practicable;
- Reduce or control, to the extent practicable, the impact of subsurface sources of volatile organic compounds on the groundwater quality.

XII. Description of Remedial Alternatives

As stated earlier, there are three distinct groundwater contamination areas namely, the Building I-1-23 Area (Plume 1), Buildings I-1-2/I-1-3 Areas (Plume 2), and the Area 9 Repository (Plume 3). Plume 2 will be addressed by a separate ROD Amendment. All alternatives, with the exception of the No Action alternative include groundwater monitoring. The following includes a brief description of various components of the remedial alternatives considered for this ROD Amendment.

Groundwater Extraction and Treatment component of the remedial alternatives includes the pumping and treating of groundwater in the Upper Sand aquifer.

Permeable Reactive Barrier (PRB) component of the remedial alternatives includes the construction of a continuous barrier consisting of a mixture of zero-valent iron (ZVI) and sand immediately downgradient of the CVOC plume. The reactive zone of the PRB containing the ZVI would be placed across the full depth of the Upper Sand unit, from the top of the lower clay to the bottom of the Upper Clay. As the groundwater flows through the PRB under natural gradients, the dissolved VOCs would be destroyed by chemical reactions with the ZVI.

Multiphase Extraction with Pneumatic Fracturing component of the remedial alternatives includes multiphase extraction (MPE) wells with enhancement by pneumatic fracturing to treat the VOC sources within the Upper Clay unit. The Upper Sand unit would also be treated with MPE wells. MPE is an in-situ technology that uses a high-vacuum pump(s) to extract liquid and vapor simultaneously from the subsurface through the extraction wells.

Phytoremediation component of alternatives includes planting of phreatophytic trees, including cottonwood, poplar, or willow, near the lake for phytoremediation of the shallow groundwater.

Engineered Wetland component of the alternatives includes a constructed engineered wetland treatment zone within a portion of the existing Crab Orchard Lake bay to intercept the VOC-impacted groundwater where it currently discharges into the bay, and to treat the discharging groundwater and surface water runoff that passes through the drainage swales to reduce VOC concentrations to non-detectable levels before water enters the main body of the lake.

Alternative concentration limits (ACLs) component are used in lieu of drinking water standards. ACLs will be established by developing baseline groundwater quality levels for the shallow aquifer near the groundwater/surface water interface within the plume discharge area, and then employing an analytical method to determine what level of groundwater contamination would constitute a statistically significant increase in VOC concentrations at selected points of compliance for groundwater quality. If future groundwater monitoring confirms a statistically significant increase in the contaminant concentrations, the need for further remedial action would be evaluated.

In-Situ Reductive Dechlorination includes the addition of a substrate into the source area soil and groundwater to stimulate the in-situ destruction of VOCs in both the Upper Sand and Upper Clay through biological reductive dechlorination.

Electrical Resistive Heating (ERH) technology is a thermally enhanced soil vapor extraction (SVE) technique that targets both contaminated soil and groundwater. This alternative involves the use of electrical current transmitted through the contaminated soil zones in the Upper Clay and Upper Sand, using a large number of metal electrodes to heat the groundwater to the boiling point, with removal of the resulting steam and hot soil vapor using a soil vapor extraction system, and processing/treatment of the extracted steam/water/vapor for removal of VOCs.

Monitored Natural Attenuation component of the remedial alternatives includes regular periodic monitoring of groundwater and surface water to assess the attenuation of contaminant plumes via natural chemical, physical, and biological processes. The monitoring data are evaluated to determine if the groundwater contaminant plumes are stable or receding, and to determine the rate of change of the VOC concentrations.

Institutional Controls component of the remedial alternatives prohibits the installation of potable water wells until the groundwater is restored to the drinking water standards.

The following remedial alternatives are in addition to the ANo Action@ alternative which is required under NCP to establish a baseline for comparison of the effectiveness of the remedial

alternatives. The "No Action" alternative is considered ineffective at achieving the remedial action objectives of bringing the groundwater to beneficial uses or to reduce/control the impact of subsurface sources of the VOCs on the groundwater quality. The alternatives are numbered to correspond with numbers in the FFS Report.

Groundwater Plume near Building I-1-23 (Plume 1)

- Alternative A1 - Excavation (within 10 mg/kg CVOC contour in the Upper Clay unit), Groundwater Extraction and Treatment, Phytoremediation, and Institutional Controls

- Alternative A2 - Excavation (within 1 mg/kg CVOC contour in the Upper Clay unit), Groundwater Extraction and Treatment, Phytoremediation and Institutional Controls

- Alternative B - Excavation (within 10 mg/kg CVOC contour in the Upper Clay unit), Permeable Reactive Barrier, Phytoremediation and Institutional Control

- Alternative C - Multiphase Extraction with Pneumatic Fracturing, Groundwater Extraction and Treatment, Phytoremediation and Institutional Control

- Alternative D - Excavation (within 10 mg/kg CVOC contour in the Upper Clay unit), Phytoremediation including Engineered Wetland, Alternate Concentration Limits, and Institutional Controls

- Alternative E - Phytoremediation including Engineered Wetland, Alternate Concentration Limits, and Institutional Controls

- Alternative F - Excavation (within 10 mg/kg CVOC contour in the Upper Clay unit), In-Situ Reductive Dechlorination, Phytoremediation including Engineered Wetland, Alternate Concentration Limits, and Institutional Controls

- Alternative G - Electrical Resistive Heating in source areas within an estimated 1 mg/kg CVOC zones through the full depth of Upper Clay and Upper Sand units, Phytoremediation, and Institutional Controls

Groundwater Plume near Building I-1-2/I-1-3 (Plume 2)

- Alternative A - Limited Excavation, Multiphase Extraction with Pneumatic Fracturing, and Institutional Controls

- Alternative B - Permeable Reactive Barrier and Institutional Controls

- Alternative C - Alternate Concentration Limits and Institutional Controls

- Alternative D - Excavation (within the 10 mg/kg VOC contour), Alternate Concentration Limits, and Institutional Controls

- Alternative E - Excavation (within the 10 mg/kg VOC contour), In-Situ Reductive Dechlorination with Pneumatic Fracturing, Alternate Concentration Limits, and Institutional Controls

- Alternative F - Electric Resistive Heating (within 10 mg/kg CVOC contour) and Institutional Controls

Groundwater Plume beneath the Area 9 Repository (Plume 3)

- Alternative A - Phytoremediation and Monitored Natural Attenuation

- Alternative B - Phytoremediation and Alternative Concentration Limits

XIII. Applicable or Relevant and Appropriate Requirements (ARARs)

The following federal and state ARARs apply to one or more of the remedial alternatives for the groundwater at Sites 32/33:

1. Chemical-specific ARARs

    - 40 CFR 141 - MCLs promulgated under the Safe Drinking Water Act.

    - 35 IAC Part 620 – Groundwater Quality, Subpart D, Section 620.405, General Prohibition Against Violations of the Groundwater Quality Standards: No person shall cause, threaten or allow the release of any contaminant to groundwater so as to cause a groundwater quality standard to be exceeded.

    - 35 IAC Part 620 – Groundwater Quality, Subpart D, Section 620.410, Class I Groundwater Quality Standards.

    - 35 IAC Part 620 – Groundwater Quality, Subpart D, Section 620.450, Alternative Groundwater Quality Standards: Applies to any chemical constituent within a Groundwater Management Zone. Following completion of corrective action allows alternate groundwater standards equal to the concentration of contaminants determined by groundwater monitoring, if such concentrations exceed the appropriate groundwater quality standards and to the extent practicable, the exceedances have been minimized and beneficial use has been returned.

    - 40 CFR 122.41 and 122.44 - Clean Water Act: If any ditch water from Sites 32/33 must be discharged to a surface water body during site preparation, the discharge shall meet the effluent standards and

prohibitions and water quality standards established under Sections 301, 302, 303, 307, 318, and 405 of the Clean Water Act.

- 35 IAC Part 302, Subpart B – General Use Water Quality Standards, specifically Part 302.208 – Numeric Standards for Chemical Constituents, and Part 302.1210 – Other Toxic Substances.

2. Action Specific ARARs

- 35 IAC Part 304, Subpart A – General Effluent Standards, specifically Parts 304.102 and 304.105 to 141 – For discharges to waters of the state.
- 35 IAC Part 305 – Monitoring and Reporting, specifically Parts 305.102 to 103 - For discharges to waters of the state.
- 35 IAC Part 306, Subpart A – Systems Reliability, specifically Part 306.102
- 35 IAC Part 309, Subpart A – NPDES Permits – Substantive requirements pertinent to construction and operation of contaminated groundwater treatment or pretreatment works and to point source discharges to waters of the state.
- 35 IAC Part 620 – Groundwater Quality, Subpart D, Section 620.250, Groundwater Management Zone (GMZ): Allows the establishment of a GMZ, a three dimensional region containing groundwater managed to mitigate impairment caused by the release of contaminants from a site; requires corrective action in a timely and appropriate manner approved by Illinois EPA.
- 40 CFR 262.34; and 264, Subparts B, C, I, J, and L - Resource Conservation and Recovery Act (RCRA), Subtitle C - Excavated material which is RCRA hazardous will be handled and stored in accordance with the substantive technical standards applicable to generators of hazardous waste and for owners and operators of hazardous waste and for owners an operators of hazardous waste storage facilities.
- 40 CFR 268 – Excavated material which is RCRA hazardous will be handled and stored in accordance with the land disposal restrictions
- 40 CFR 264, Subpart G – The excavation activities, when completed, shall meet the closure performance standards for clean closure.
- 35 IAC Part 724 design requirements – The excavation and storage activities must also meet any more stringent State of Illinois regulations.
- 40 CFR 761.65 - Clean Air Act – During excavation the national ambient air quality standards (NAAQS) for particulate matter and lead shall not be exceeded.
- 35 IAC Subtitle B – Air Pollution, Part 201 – Substantive permitting requirements under Parts 201.141, .143, .152-.165, .207-.210, .261-.265, .282-.283, .310-.312 for construction or modification of an emission source.
- 35 IAC 704 – UIC Permit Program; 35 IAC Part 730 – Underground Injection Control Operating requirements – Substantive permitting

requirements for underground injection of hazardous liquids (Class IV UIC well) or non-hazardous fluid (Class V UIC well). Injection of contaminated fluid into underground sources of drinking water in excess of any primary drinking water regulations is prohibited. 35 IAC Part 724.124(c) exempts Class IV wells (hazardous) from this prohibition on RCRA and CERCLA sites; however, no exemption exists for Class V wells.

- 35 IAC Part 722 – Standards Applicable to Generators of Hazardous Waste – If solid waste (defined per 35 IAC Part 721.102) is generated, the generator must determine if that waste is hazardous.
- 35 IAC Subtitle G – Waste Disposal, specifically Parts 724 and 728 – If hazardous waste is present on a site, pertinent requirements of hazardous waste treatment, storage, and disposal under 35 IAC Subtitle G (Waste Disposal) must be followed.
- 35 IAC Part 808 – Special Waste Classifications – Generators of a waste must classify the waste. A special waste (defined per Section 3.45 of Illinois Environmental Protection Act) determination is required under 35 IAC Part 808.12. Management of special waste must be in accordance with 35 IAC Subtitle G (Waste Disposal), including 35 IAC Part 809 (Special Waste Hauling) and 35 IAC Part 810 (Solid Waste Disposal).
- 40 CFR 264.114 – RCRA, Subtitle C – During remediation and closure all equipment, structure, and soils that are used on /with RCRA hazardous material must be properly decontaminated or disposed of.
- 35 IAC Part 724 – Decontamination of equipment, structures, and soils that are used on/with RCRA hazardous materials must meet any more stringent regulatory decontamination or disposal standards of the State of Illinois.
- 40 CFR 50.6 – During backfilling activities the NAAQS for particulate matter shall not be exceeded.
- 40 CFR 264, Subpart F – RCRA Subtitle C – Groundwater monitoring for the remediated sites shall be in accordance with the groundwater monitoring requirements of RCRA.
- 29 CFR 1910.120 and 1926, Subparts C, D, E, and P – Occupational Safety and Health Act (OSHA) – During all remedial activities the requirements of OSHA for the training and safety of workers will be observed.

3. Location Specific ARARs

- National Wildlife Refuge Administration Act (16 USC 668dd).
- Fish and Wildlife Coordination Act (16 USC 661-666).
- Migratory Bird Treaty Act of 1918 (16 USC 703-711, as amended.
- Endangered Species Act – 16 USCA Sections 1531 to 1544.
- Archeological and Historic Preservation Act – 16 USCA Sect. 469
- Native American Graves Protection and Repatriation Act – PL 101-601

XIV. Evaluation of Alternatives

a. Evaluation Criteria

U.S. EPA's evaluation of remedial alternatives is based on the nine criteria set forth in the National Contingency Plan (NCP), 40 CFR Part 300. These criteria are described below.

A remedial alternative is judged first in terms of the threshold criteria of protecting human health and the environment and complying with Applicable or Relevant and Appropriate Requirements (ARARs). If a proposed remedy meets these two criteria, it is then evaluated against the balancing and modifying criteria in order to arrive at a final recommended alternative.

Threshold Criteria

1. Overall protection of human health and the environment: U.S. EPA determines whether an alternative adequately protects human health and the environment from unacceptable risks posed by hazardous substances, pollutants, or contaminants present at the site.

2. Compliance with ARARs: U.S. EPA evaluates whether an alternative attains applicable or relevant and appropriate requirements under federal environmental laws and state environmental or facility citing laws or provides grounds for invoking a waiver.

Balancing Criteria

3. Long-term effectiveness and permanence: U.S. EPA considers the ability of an alternative to maintain protection of human health and the environment over time, and the reliability of such protection.

4. Reduction of contaminant toxicity, mobility, or volume through treatment: U.S. EPA evaluates the degree to which an alternative uses treatment to address the principal threats posed by the site.

5. Short-term effectiveness: U.S. EPA considers the length of time needed to implement an alternative and the risks the alternative poses to workers, residents, and the environment during implementation.

6. Implementability: U.S. EPA considers the technical and administrative feasibility of implementing the alternative, such as relative availability of goods and services.

7. Cost: U.S. EPA estimates an alternative's capital and O&M costs and calculates the present worth cost. Present worth cost is the total cost of an alternative over time in terms of today's dollars.

Modifying Criteria

8. State acceptance: U.S. EPA considers any concerns the state has raised with respect to the preferred alternative, other alternatives or with ARARs or ARAR waivers.

9. Community Acceptance: U.S. EPA considers which components of the alternatives interested persons in the community support, have reservations about, or oppose.

b. Application of the Evaluation Criteria to the Cleanup Alternatives

As part of the evaluation process, each alternative is evaluated against the nine criteria outlined above. The ROD Amendment briefly summarizes the outcome of this evaluation with the goal of identifying the alternative that best meets the nine criteria. This ROD Amendment evaluates cleanup alternatives for Plumes 1 and 3 only. Evaluation of Cleanup alternatives for Plume 2 will be made in a separate ROD Amendment.

Groundwater Plume near Building I-1-23 (Plume 1)

1. Overall Protection of Human Health and the Environment:

All of the alternatives, with the exception of the ANo Action@ alternative include Phytoremediation and Institutional Controls to prohibit the installation of potable water wells until groundwater is restored to the drinking water standards, will provide overall protection of human health and the environment.

Alternative A2 provides the most assurance that human health and the environment will continue to be protected over the duration of the remedy and beyond. Under Alternative A2, Excavation (within 1 mg/kg CVOC contour in the Upper Clay), Groundwater Extraction and Treatment, Phytoremediation and Institutional Controls, the bulk of the soil contamination, including NAPL mass, in the Upper Clay will be removed. The groundwater extraction and treatment system will consist of extraction wells (or a single well, if sufficient) installed to capture groundwater contamination in the Upper Sand unit and an above groundwater treatment system to remove and treat contaminants from the extracted groundwater. At the downgradient edge of the plume, Poplar Trees or Eastern Cottonwood trees representing the Phytoremediation component of the remedy will be planted to capture any residual groundwater contamination near the lake. As the final component of the remedy, Institutional Controls will be used to prevent future use of groundwater at the site until groundwater is restored to drinking water standards.

The modeling simulations show that Alternatives A2 and G would bring groundwater to beneficial use in approximately 40 and 75 years, respectively. All other alternatives would take more than 200 years to bring groundwater to beneficial use.

2. Compliance with ARARs:

Alternatives A1, A2, B, C and G, would meet the ARARs identified in this ROD Amendment. Alternate concentration limits (ACLs) would have to be established for Alternatives D, E, and F.

By excavating most of the contaminated soil in the Upper Clay unit, Alternative A2 will remove approximately 97% of the NAPLs in the Upper Clay. Based on groundwater modeling results, NAPLs in the Upper Sand unit will be removed within 11 years of groundwater extraction and treatment and the remaining NAPLs in the Upper Clay unit will be removed within 14 years after excavation of the contaminated soil. Groundwater will be restored to drinking water standards in approximately 40 years.

Based on the calculations presented in Appendix B of the FFS Report, the NAPL and sorbed VOC mass in the Upper Sand would be fully removed within approximately three years after the start of ERH treatment (Alternative G), and the NAPL and sorbed VOC mass in the Upper Clay would be fully removed in approximately 65 years from the start of treatment. Groundwater standards would be met over the entire plume area within approximately 75 years.

3. Long-Term Effectiveness and Permanence

All of the alternatives, with the exception of the No Action alternative, include Phytoremediation or Phytoremediation with Engineered Wetland as a component of the remedy. Phytoremediation will be effective in achieving limited long-term effectiveness by reducing the volume of contaminated groundwater and the mass of chlorinated VOCs discharging to the Crab Orchard Lake or other surface water locations. Alternatives A1, A2, B, C, D, F, and G which include excavation and/or groundwater treatment as components of the remedy, will provide long-term effectiveness and permanence.

Although all of these alternatives provide long-term effectiveness and permanence, the remediation benefits will not be permanent until all of the NAPL mass had been removed from the Upper Clay by natural processes which will take approximately 14 years for Alternative A2, 65 years for Alternative G, and more than 200 years for Alternatives A1, B, C, D, and E.

Alternative A2 provides the greatest degree of long-term effectiveness and permanence since most of the source material including NAPL mass will be removed in the Upper Clay unit and groundwater extraction and treatment in the Upper Sand unit will restore the groundwater to drinking water standards in approximately 40 years. Alternative G would restore the groundwater to beneficial use in approximately 75 years.

4. Reduction of toxicity, mobility, and volume through treatment:

All of the alternatives are capable of achieving some reduction in the toxicity, mobility and volume of contamination through treatment. Alternatives A1, A2, and C provide greater reduction in mobility of VOCs than the other alternatives, by focusing the groundwater extraction within the main source area. Groundwater extraction under these three alternatives would also provide capture and removal of dissolved VOCs over a broader area than the in-situ groundwater treatment zone provided by the permeable reactive barrier (PRB) in Alternative B, thereby providing greater reduction in both volume and mobility of VOCs over time than the PRB. Alternative A1, however, will not reduce VOC mobility, if the extraction wells stopped operation within 11 years (short-term option), due to the expected rebound of the VOC plume.

Alternative A2 would provide removal or destruction of more of the VOC source mass in a shorter time than the other alternatives. Alternatives B, D, F, and G would do little to reduce the mobility of the VOC source mass that would remain after completing the "active" phase of the source area remediation.

Because Alternatives A2, C, F, and G are expected to remove or destroy more VOCs than other alternatives, they would also provide greater reduction of VOC toxicity. However, under Alternatives B and F, there is potential that if the PRB (Alternative B) or the in situ biodegradation (Alternative F) does not provide complete destruction of the VOCs, breakdown products such as vinyl chloride that have higher toxicity than the parent compounds may be present in the groundwater at some locations.

5. Short-Term Effectiveness:

The Alternatives that include source area soil excavation and off-site disposal as a component of the remedial action (Alternatives A1, A2, B, D, and F) would present a higher level of potential exposure of construction workers to VOCs during implementation of the alternative than the alternatives that do not include soil excavation (Alternatives C, E, and G). There would also be a slightly increased risk of exposure of the general public to VOCs during transport of the soil for disposal. Alternative B would have recurring potential for adverse exposures during replacement of the PRB, which has been assumed to be required every 20 years.

Potential exposures to steam, hot water, hot soil vapor, condensate containing concentrated VOCs, and electrical hazards during operation of the ERH system (Alternative G) would result in greater potential short-term exposures to remediation workers and employees working in nearby buildings. Proper design of the ERH system and taking proper health and safety precautions, however, would eliminate these concerns. The design may include air monitoring inside nearby buildings to address the issue of VOC vapors that may not be fully captured by the ERH system and which may migrate beneath and into the buildings during implementation. Air monitoring instruments (e.g., Photoacoustic multigas analyzer) would be placed inside buildings and samples collected at regular intervals throughout the duration of the remediation. If VOCs are detected above their pre-determined action levels, the ERH system could be designed to automatically shut down and/or to evacuate the occupants of the building. To prevent adverse impact to building instrumentation, operations of safety, the ERH system would includes isolation transformers that prevent the uncontrolled flow of electricity outside of the electrode arrangement. Thus it is physically impossible for electricity to enter the nearby building electrical system via the existing building grounding grid.

All of the alternatives include some form of phytoremediation as a component of the work. The vegetation provided for phytoremediation would not reach its peak groundwater remediation effectiveness until roughly three years after planting.

Alternatives A1, A2, and C would provide more rapid short-term improvement in groundwater quality downgradient of the VOC source area than the other alternatives, due to the groundwater extraction component of the alternatives.

6. *Implementability:*

Alternatives A1, A2, C, and F are readily implementable relative to all other alternatives. The soil excavation component in several of the alternatives (Alternatives A1, A2, B, D, and F) is expected to be implementable, despite the presence of several existing underground utilities. The successful completion of the PCB soil excavations in 1996 demonstrate that the existing utilities in this area can be avoided during excavation work. Alternative B would have considerable uncertainty regarding the constructability of the PRB at this location, however, owing to the depth and thickness of the Upper Sand unit. The extent of these construction challenges would not be known until additional pilot soil borings were completed during pre-design fieldwork. Existing buried utilities in the location of the PRB would also present an impediment to construction. PRB is a patented technology available from limited number of contractors with patent implementation rights and a site use license and fee are required. Pneumatic fracturing of the clay under Alternate C, certain types and methods of bio-substrate addition as included under Alternative F, and the use of ERH technology under Alternative G are also patented technologies offered by limited number of vendors with patent implementation rights. Under Alternative G, air monitoring inside nearby buildings during implementation may be needed to ensure that VOC vapors are not migrating beneath and into the buildings. A high level of coordination with GDOTS is needed to ensure that the implementation of the ERH system would not unreasonably interfere with GDOTS' ongoing activities at the site.

7. Cost:

The estimated capital, annual O&M, and present worth cost for each of the alternatives has been calculated for comparative purposes and is presented in Table 1.

Table 1
Summary of Estimated Costs for Each Alternative for Plume 1

	Total Capital Cost	Total Cost	Total Present Worth Cost
A1	$830,000	$5,182,000	$3,719,000
A2	$2,747,000	$5,688,000	$4,914,000
B	$2,276,000	$5,836,000	$4,415,000
C	$1,319,000	$5,809,000	$4,352,000
D	$1,074,000	$3,062,000	$2,391,000
E	$706,000	$2,740,000	$2,046,000
F	$1,410,000	$3,564,000	$2,908,000
G	$2,930,000	$4,322,000	$3,837,000

(Total present worth value is for a 30-year period and an annual discount rate of 3.2 %)

Alternative E has the lowest total present worth cost and Alternative A2 has the highest. This is because Alternative E includes no removal of source material and limited operation and maintenance costs while alternatives A1 and A2 include a much longer projected period of operation and maintenance costs. Alternative G has the highest capital costs. Although Alternative A2 is more expensive than other alternatives, based on the groundwater modeling results, it brings the groundwater to MCLs and State of Illinois Class I Groundwater standards in the shortest timeframe of about 40 years when compared with other alternatives which would take more than 100 years.

8. State Acceptance:

The Illinois EPA has provided support to U.S. EPA throughout the re-evaluation process. The Illinois EPA concurs with the selected remedy.

9. Community Acceptance:

U.S. EPA received five written/email comments, including comments from Schlumberger and GDOTS. Three of the comments received were supportive of U.S. EPA's preferred remedies. Of the remaining two, Schlumberger commented on U.S. EPA's preferred remedies. GDOTS expressed concerns regarding the preferred remedy's potential impact on GDOTS' operations and health and safety of its employees. The responsiveness summary included in this ROD Amendment addresses these comments.

Groundwater Plume beneath the Area 9 Repository (Plume 3)

1. Overall Protection of Human Health and the Environment:

Both Alternatives A and B include Phytoremediation and Institutional Controls to prohibit installation of potable water wells until groundwater is restored to drinking water standards. Both alternatives are protective of human health and the environment.

2. Compliance with ARARs:

The time frame to bring groundwater to drinking water standards is through natural attenuation process and would take longer than 100 years. Alternate Concentration limits have to be established for Alternative B. Compliance with the surface water quality standards will be enhanced by the phytoremediation that is included as a component of both alternatives.

3. Long-Term Effectiveness and permanence:

Alternatives A and B are both expected to supplement the existing effective natural attenuation processes by planting additional treatment of shallow groundwater in low lying areas at the Center and East Swales that receive the discharge of the merged groundwater plumes on the eastern side of the Repository. Both alternatives would provide the same degree of long-term

effectiveness and permanence through the natural attenuation process, phytoremediation, and institutional controls.

4. Reduction of toxicity, mobility, and volume through treatment:

Both alternatives would provide the same degree of reduction in the toxicity, mobility, and volume of the site contaminants by allowing natural processes to breakdown the contamination into harmless by products. The phytoremediation component of both these alternatives would provide further reduction in volume, mobility, and toxicity through phytoremediation of the VOCs by the trees and prairie grasses.

5. Short-Term Effectiveness:

Both alternatives present a very low short- or long-term risk to the community, workers, and the environment during implementation. The existing natural attenuation process is effectively controlling the VOC source area impacts. Therefore, the time required for the vegetation planted for phytoremediation to reach maturity will not impair the short-term effectiveness.

6. Implementability:

The Phytoremediation component of both Alternatives A and B is readily implementable.

7. Cost:

The estimated capital, annual O&M, and present worth cost for each of the alternatives has been calculated for comparative purposes and is presented in Table 2.

Table 2
Summary of Estimated Costs for Each Alternative for Plume 3

	Total Capital Cost	Total Cost	Total Present Worth Cost
Alternative A	$199,400	$1,854,800	$1,322,400
Alternative B	$174,800	$1,708,300	$1,210,300

(Total present worth value is for a 30-year period and an annual discount rate of 3.2 %)

8. State Acceptance:

The Illinois EPA has provided support to U.S. EPA throughout the re-evaluation process. The Illinois EPA concurs with the selected remedy.

9. Community Acceptance:

U.S. EPA received five written/email comments, from both the public and potentially responsible parties at the Crab Orchard Site. The responsiveness summary included in this ROD Amendment addresses these comments.

XV. The Selected Remedy

Groundwater Plume near Building I-1-23 (Plume 1)

The Selected remedy for the Groundwater Plume near Building I-1-23 (Plume 1) is Alternative A2, which includes Excavation (within 1 mg/kg CVOC contour in the Upper Clay unit) and Off-site Disposal of CVOC-contaminated soil, Groundwater extraction and Treatment in the Sand unit beneath the Upper Clay, Phytoremediation, and Institutional Controls.

The selected remedy was preferred over other alternatives because it is expected to bring the groundwater to MCLs within a relatively shorter time frame of approximately 40 years with a short-term pump and treat duration of only 11 years. Based on the FFS Report, the total present worth cost of this alternative is $4,914,000. Although other alternatives cost less than the selected remedy, based on groundwater modeling results, the time frame for all other alternatives to bring the groundwater to the drinking water standards is longer than 100 years, unless these alternatives included a long-term pump and treatment technology.

Excavation and off-site disposal of VOC-contaminated material to the 1 mg/kg VOC contour in the Upper Clay unit would remove most of the NAPLs in the Upper Clay unit. After the excavation component of the remedy is complete, additional soil and groundwater samples at Plume 1 are collected to establish new baseline conditions at the site. The new data collected will be input into the groundwater model to arrive at a more refined timeframe for bringing groundwater to MCLs. An extraction well system will be designed and installed to remove dissolved VOC source mass from the Upper Sand unit. Groundwater extraction will continue for a period of approximately 11 years at which point all the NAPL mass is expected to be removed in the Upper Sand unit. It is expected that the rate of VOC mass removal closely matches the predictions made based on the results of the new groundwater modeling simulations. Five years after the extraction system is in place, U.S. EPA will evaluate the progress of VOC mass removal in the Upper Sand unit. If it is determined that it would take a significantly longer time frame than that predicted by the groundwater model to remove NAPL mass in the Upper Sand unit, U.S. EPA will reevaluate the cleanup action at this plume area and may stop further extraction of groundwater in the Upper Sand unit and consider issuing a technical impracticality waiver.

Phytoremediation component of this selected remedy includes the planting of phreatophytic trees, including poplar, willow, or Eastern Cottonwood trees near the lake for phytoremediation of the shallow groundwater. These trees uptake TCE and degrade it to several known metabolic products, including trichloroethanol, trichloroacetic acid, and dichloroacetic acid. Final selection of the species of trees to be used should be made during the remedial design phase. Phytoremediation will reduce the volume of contaminated groundwater and the mass of CVOCs discharging to Crab Orchard Lake or other surface water locations by slowing down or reversing shallow groundwater flow toward the drainage swales and the lake, and by the uptake of dissolved CVOCs. Institutional Controls will prohibit the installation of potable water wells until the groundwater is restored to drinking water standards. Based on the FFS Report, the total present worth cost of the remedy is $4,914,000.

Groundwater Plume beneath the Area 9 Repository (Plume 3)

The Selected remedy for the Groundwater Plume beneath the Area 9 Repository (Plume 3) is Alternative A, which includes Phytoremediation, Monitored Natural Attenuation, and Institutional Controls.

Phytoremediation component of this selected remedy includes the planting of phreatophytic trees, including poplar, willow, or Eastern Cottonwood trees near the lake for phytoremediation of the shallow groundwater. These trees uptake TCE and degrade it to several known metabolic products, including trichloroethanol, trichloroacetic acid, and dichloroacetic acid. Final selection of the species of trees to be used should be made during the remedial design phase. Phytoremediation will reduce the volume of contaminated groundwater and the mass of CVOCs discharging to Crab Orchard Lake or other surface water locations by slowing down or reversing shallow groundwater flow toward the drainage swales and the lake, and by the uptake of dissolved CVOCs. Institutional Controls prohibit the installation of potable water wells until the groundwater is restored to drinking water standards.

Based on existing data, the Area 9 Repository plume is being degraded by natural processes. Also, the Area 9 plume is not migrating very far downgradient of the source area. Concentrations of total VOCs in groundwater beneath the Repository (>35,000 µg/L) are being reduced to 10 to 30 µg/L within a distance of about 200 feet along the groundwater flow path. Therefore, the natural attenuation process together with phytoremediation and institutional controls will provide the necessary protection of human health and the environment with the assurance that ongoing monitoring can be used to evaluate the success of this alternative. There was no significant difference between Alternatives A and B. However, all of the components of Alternative A (phytoremediation, monitored natural attenuation, and institutional controls) were previously included in U.S. EPA's June 2000 ESD for the PCB OU. Therefore, U.S. EPA has selected Alternative A, which retained the remedial components previously chosen in the ESD. Based on the FFS Report, the total present worth cost of this alternative is $1,322,400.

Institutional Controls

Area 9 Landfill (Site 32) and the Area 9 Building Complex (Site 33) are located in an industrial area within the refuge. These areas are expected to remain as industrial areas in the foreseeable future. Groundwater at this site is State of Illinois Class I Potable Groundwater Resource and is contaminated with TCE and other chlorinated solvents well above MCLs and Illinois Class I *Groundwater Quality Standards*.

Currently, there is no risk to human health, because presently the groundwater is not being used for drinking water. Groundwater at the site is a potential future source of drinking water as designated by the State of Illinois Groundwater Classification. Institutional controls are necessary to prohibit the installation of potable water wells until the groundwater is restored to drinking water standards.

The Crab Orchard National Wildlife Refuge is owned by the U.S. Government and currently is administered by FWS. FWS is currently finalizing a Land Use Control (LUC) Plan which incorporates institutional controls required under the records of decisions signed for all operable units within the Crab Orchard Site. The FWS is responsible for implementing, maintaining, reporting on, and enforcing the land use controls. DOI shall submit a LUC Plan, as a Primary Document under the FFA, to U.S. EPA for review and approval in accordance with the review and approval schedule in the FFA, that shall contain implementation and maintenance actions, including periodic inspections. FWS will incorporate the Institutional Controls (Figure 2) to prohibit the installation of potable water wells until groundwater is restored to drinking water standards into its LUC Plan.

XVI. Statutory Determinations

Under CERCLA §121and the NCP, the lead agency must select remedies that are protective of human health and the environment, comply with applicable or relevant and appropriate requirements (unless a statutory waiver is justified), are cost-effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes as a permanent element a bias against off-site disposal of untreated wastes. The following sections discuss how the revised remedies meet these statutory requirements.

A. Protection of Human Health and the Environment

The revised remedy for Plume 1 includes excavation of contaminated materials in the Upper Clay unit, groundwater extraction and treatment in the Upper Sand unit, Phytoremediation and Institutional Controls to prohibit installation of potable water wells at the site until groundwater is restored to the drinking waters standards will provide protection of human health and the environment. Groundwater at this site is classified as State of Illinois Class I Potable Groundwater Resource. Through excavation in the Upper Clay unit, most of the TCE contaminated material including most of NAPL mass is removed. Based on the groundwater model predictions, groundwater extraction and treatment in the Upper Sand unit will remove all of the NAPL mass in approximately 10 years. The remaining NAPL mass in the Upper Clay unit would be removed in 14 years. Groundwater would be restored to drinking water standards within a timeframe of approximately 40 years. In addition, this will also significantly reduce any potential long-term risk due to soil vapor intrusion of TCE and other VOCs to the occupants of nearby buildings.

The revised remedy for Plume 3 includes Monitored Natural Attenuation, Phytoremediation, and Institutional Controls to prohibit the installation of potable water wells until groundwater is restored to drinking water standards. The natural attenuation processes at this VOC source area, together with the additional treatment of shallow groundwater in low lying areas at the Center and East Swales through phytoremediation, and Institutional Controls will provide protection of human health and the environment.

There are no short-term threats associated with the revised remedies for Plumes 1 and 3 that cannot be readily controlled.

B. Compliance with ARARs

The selected remedies for groundwater remediation would meet the ARARs presented in the following sections through the removal/treatment of principal threat wastes at Plume 1 and through monitored natural attenuation at Plume 3. This ROD Amendment will not affect other ARARs selected in the 1990 ROD for the PCB Areas Operable Unit.

1. Chemical Specific ARARs

Safe Drinking Water Act: MCLs (40 CFR 141) are relevant an appropriate for site groundwater. The groundwater at these sites are not currently being used as a source of drinking water, but the aquifer at these sites could potentially be used as a drinking water source in the future.

40 CFR 122.41 and 122.44 - Clean Water Act: If ditch water from Sites 32/33 must be discharged to surface water body during site preparation, the discharge shall meet the effluent standards and prohibitions and water quality standards established under Sections 301, 302, 303, 307, 318, and 405 of the Clean Water Act.

Illinois Groundwater Quality Standards: 35 IAC Part 620, Subpart D, Section 620.405, General Prohibitions Against Violations of the Groundwater Quality Standards – Exceedances of Illinois' Class I Groundwater Quality Standards are impetus for corrective action. Undertaking the recommended remedial alternatives in this ROD amendment will correct these violations.

Illinois Groundwater Quality Standards: 35 IAC Part 620, Subpart D, Section 620.410 Illinois Class I Groundwater Standards - Since the Illinois Class I Groundwater Quality Standards for the contaminants of concern are the same as MCLs, Illinois groundwater standards would be met.

Illinois Groundwater Quality Standards: 35 IAC Part 620, Subpart D, Section 620.450, Alternative Groundwater Quality Standards apply to any chemical constituent within a Groundwater Management Zone. Following completion of corrective action the U.S. EPA may allow the responsible party to petition the State of Illinois to obtain alternate groundwater standards equal to the concentration of contaminants determined by groundwater monitoring. This is to be allowed only if such concentrations exceed the appropriate groundwater quality standards and to the extent practicable, the exceedances have been minimized and beneficial use has been returned.

General Use Water Quality Standards: 35 IAC Part 302, Subpart B, Section 302.208 – Numeric Standards for Chemical Constituents and Part 302.1210 – Other Toxic Substances. Surface water standards are applicable, if site-related chemicals impact surface water in area drainage swales or lakes.

2. Action Specific ARARs:

40 CFR 50.6 and 50.12 – Clean Air Act: During excavation and backfilling activities the National Ambient Air Quality Standards (NAAQS) for particulate matter shall not be exceeded.

40 CFR 262.34 and 264, Subparts B, C, I, J, and L – RCRA Subtitle C: - Excavated material which is RCRA hazardous will be handled and stored in accordance with the substantive technical standards applicable to generators of hazardous waste and for owners and operators of hazardous waste storage facilities.

40 CFR 264, Subpart G: – The excavation activities, when completed, shall meet the closure performance standards for clean closure.

40 CFR 264.114 RCRA Subtitle C: During remediation and closure all equipment, structures, and soils that are used on/with RCRA hazardous materials must be properly decontaminated or disposed of. Decontamination of equipment, structures, and soils that are used on/with RCRA hazardous materials must meet any more stringent regulatory decontamination or disposal standards of the State of Illinois (35 IAC Part 724).

40 CFR 264 Subpart F: Groundwater monitoring for the remediated sites shall be in accordance with the groundwater monitoring requirements of 40 CFR 264 Subpart F.

40 CFR 268: Excavated material which is RCRA hazardous will be handled and stored in accordance with the land disposal restrictions. The excavation and storage activities must also meet any more stringent State of Illinois equivalent provisions (35 IAC Part 724 requirements)

40 CFR 761.65 Toxic Substances Control Act: Excavated material which contains PCBs at concentrations of 50 parts per million will be handled and stored in accordance with the requirements of 40 CFR 761.65.

35 IAC Subtitle B Part 201: Air Pollution – Substantive permitting requirements under Parts 201.141, .143, .152-.165, .207-.210, .261-.265, .282-.283, .310-.312 for construction or modification of an emission source.

35 IAC Part 304, Subpart A, Parts 304.102 and 304.105 to 304.141: General Effluent Standards for discharges to waters of the state.

35 IAC Parts 305.102 to 305.103: Monitoring and Reporting for discharges to waters of the state.

35 IAC Part 306, Subpart A: Systems Reliability – Part 306.102

35 IAC Part 309, Subpart A: NPDES Permits - Substantive requirements pertinent to construction and operation of contaminated groundwater treatment or pretreatment works and to point source discharges to waters of the state.

35 IAC Part 620, Subpart D, Section 620.250: Establishing a GMZ, a three dimensional region containing groundwater managed to mitigate impairment caused by the release of contaminants at Sites 32/33, allows remediation to proceed without the State of Illinois taking enforcement action for the violation. Requires corrective action in a timely and appropriate manner approved by Illinois EPA.

35 IAC Part 722: Standards Applicable to Generators of Hazardous Waste – If solid waste (defined per 35 IAC Part 721.102) is generated, the generator must determine if that waste is a hazardous waste.

35 IAC Subtitle G, Parts 724 and 728: Waste Disposal - If hazardous waste is present on a site, pertinent requirements of hazardous waste treatment, storage, and disposal under 35 IAC Subtitle G (Waste Disposal) must be followed.

40 CFR 761.65: Clean Air Act – During excavation the national ambient air quality standards (NAAQS) for particulate matter shall not be exceeded.

35 IAC Part 808: Special Waste Classifications – Generators of a waste must classify the waste. A special waste (defined per Section 3.45 of Illinois Environmental Protection Act) determination is required under 35 IAC Part 808.12. Management of special waste must be in accordance with 35 IAC Subtitle G (Waste Disposal), including 35 IAC Part 809 (Special Waste Hauling) and 35 IAC Part 810 (Solid Waste Disposal).

29 CFR 1910.120 and 1926, Subparts C, D, E, and P: Occupational Safety and Health Act (OSHA) – During all remedial activities the requirements of OSHA for the training and safety of workers will be observed.

3. Location Specific ARARs

National Wildlife Refuge Administration Act (16 U.S.C. 668dd): This law is applicable to areas designated as part of the National Wildlife Refuge System. It requires that remedial action that takes place at Sites 32/33 be compatible with the established purposes of the Refuge.

Endangered Species Act – 16 USCA Sections 1531 to 1544: This law is applicable, if endangered species or critical habitat is present at Sites 32/33.

Archeological and Historic Preservation Act – 16 USCA Sect. 469: This law is applicable to any archeological or historical artifact uncovered during remedial activities.

Native American Graves Protection and Repatriation Act – PL 101-601: This law is applicable, if Native American or cultural items are found during remedial activities.

Migratory Bird Treaty Act of 1918 (16 USC 703-711)

Fish and Wildlife Coordination Act (16 USC 661-666)

C. Cost Effectiveness

In U.S. EPA's judgment, the revised remedy is cost-effective and meets all other requirements of CERCLA. Section 300.430(f)(1)(ii)(D) of the NCP requires U.S. EPA to evaluate the cost-effectiveness by comparing all of the alternatives which meet the threshold criteria (overall protection of human health and the environment and compliance with ARARs), against three additional balancing criteria (long-term effectiveness and permanence; reduction of toxicity, mobility, and volume through treatment; and short-term effectiveness). Overall Effectiveness is then compared to cost to determine whether a remedy is cost effective. For Plume 1, the revised remedy was chosen over other alternatives, because groundwater would be restored to beneficial use within the shortest timeframe under this remedy. The estimated present worth cost for the revised remedies for Plumes 1 and 3 are $4,914,000 and $1,322,400, respectively. The selected remedy for Plume 1 would bring the groundwater to beneficial use within the shortest timeframe of approximately 40 years compared with all other alternatives which would take significantly longer timeframes.

D. Utilization of Permanent Solutions and Alternative Treatment Technologies (or Resource Recovery Technologies) to the maximum extent practicable.

U.S. EPA has determined that the selected remedies represent the maximum extent to which permanent solutions and treatment technologies can be practicably utilized at the site. Of those alternatives that are protective of human health and the environment and comply with ARARs, U.S. EPA has determined that the revised remedies provide the best balance of trade-offs in terms of the nine criteria, while also considering the statutory preference for treatment as a principal element, the bias against off-site treatment and disposal, and State and community acceptance.

The revised remedy for Plume 1 includes excavation, off-site disposal of VOC-contaminated soil in the Upper Clay unit and extraction and treatment of VOC-contaminated groundwater in the Sand unit below the Upper Clay. Based on modeling results, the revised remedy brings groundwater to beneficial use within the shortest timeframe of approximately 40 years when compared with other remedial alternatives.

The phytoremediation component of the revised remedies for Plumes 1 and 3 would also provide treatment by taking-up TCE and degrading it to several known metabolic products, including trichloroethanol, trichloroacetic acid, and dichloroacetic acid. Phytoremediation will reduce the volume of contaminated groundwater and the mass of CVOCs discharging to Crab Orchard Lake.

E. Preference for Treatment as a Principal Element

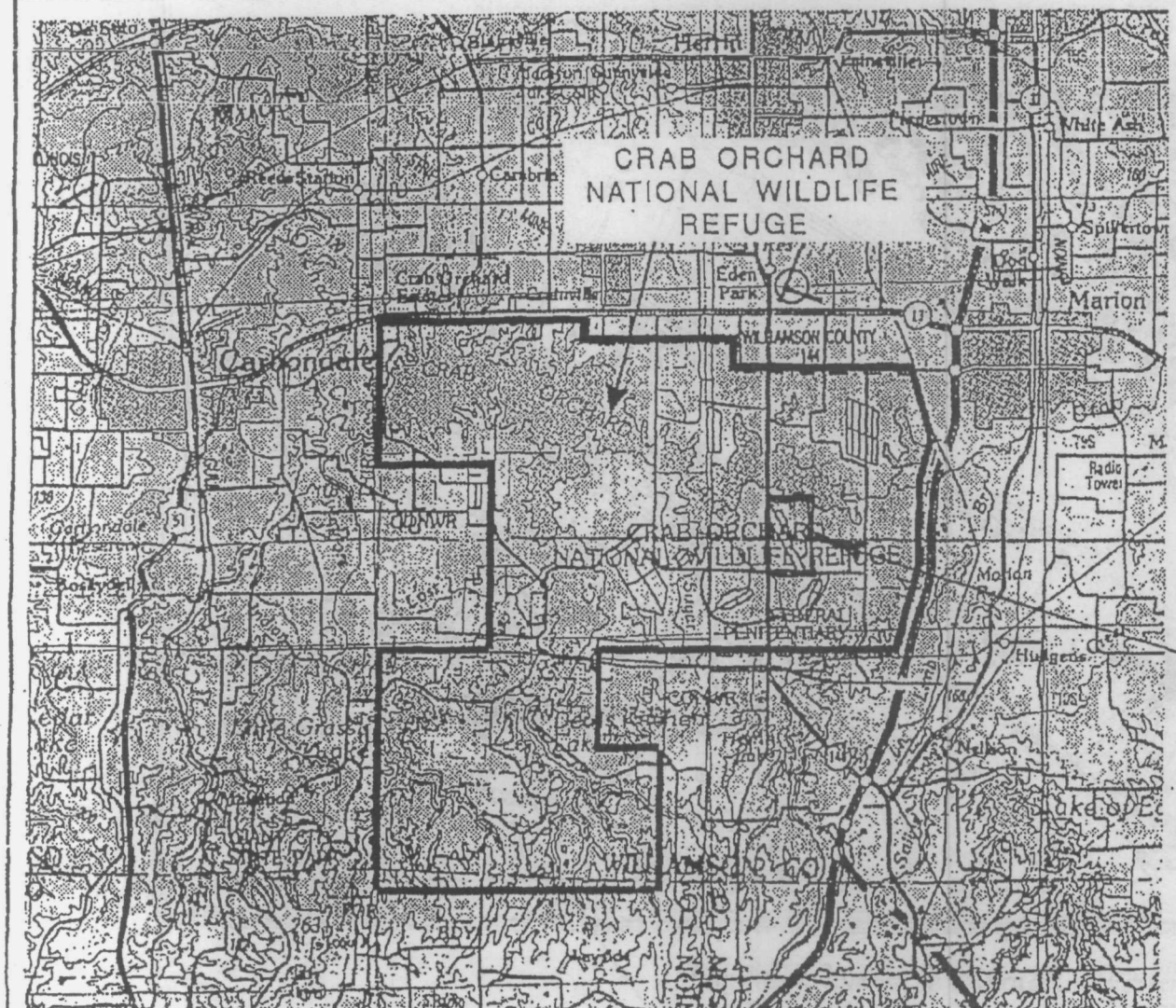
The revised remedy for Plume 1 treats the VOC-contaminated groundwater through extraction, treatment and discharge. By utilizing treatment, the statutory preference for remedies that employ treatment as a principal element is satisfied.

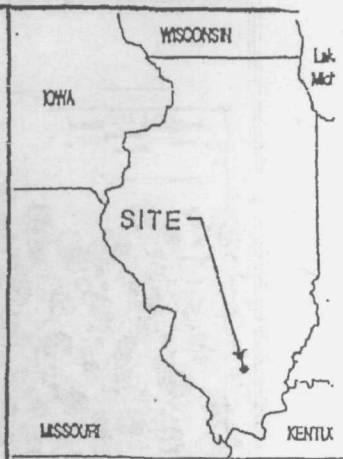
F. Five-Year Review Requirements

Because the remedies selected under this ROD Amendment and the August 1990 ROD for the PCB OU will result in hazardous substances remaining on-site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years of construction completion for the remedial action. The statutory review will be conducted to ensure that the remedies are, or will be, protective of human health and the environment.

XVII. Documentation of Changes from Proposed Plan

The Proposed Plan for the Amendment to the 1990 ROD for the PCB OU was released for public comment in April 2006. That Proposed Plan addressed Plume 1, Plume 2, and Plume 3. In response to a comments from U.S. Department of Interior, U.S. EPA decided to issue a separate ROD Amendment for Plume 2 to ensure that the Department of Interior's concerns were satisfied. U.S. EPA reviewed all comments submitted during the public comment period. U.S. EPA had determined that no significant changes to the remedies for Plume 1 and Plume 3, as originally identified in the Proposed Plan, were necessary or appropriate.





VICINITY MAP

SOURCE:
PADUCAH
1 X 2 QUADRANGLE
GEOLOGICAL SURVEY
1987

PCB OU

FIGURE 1

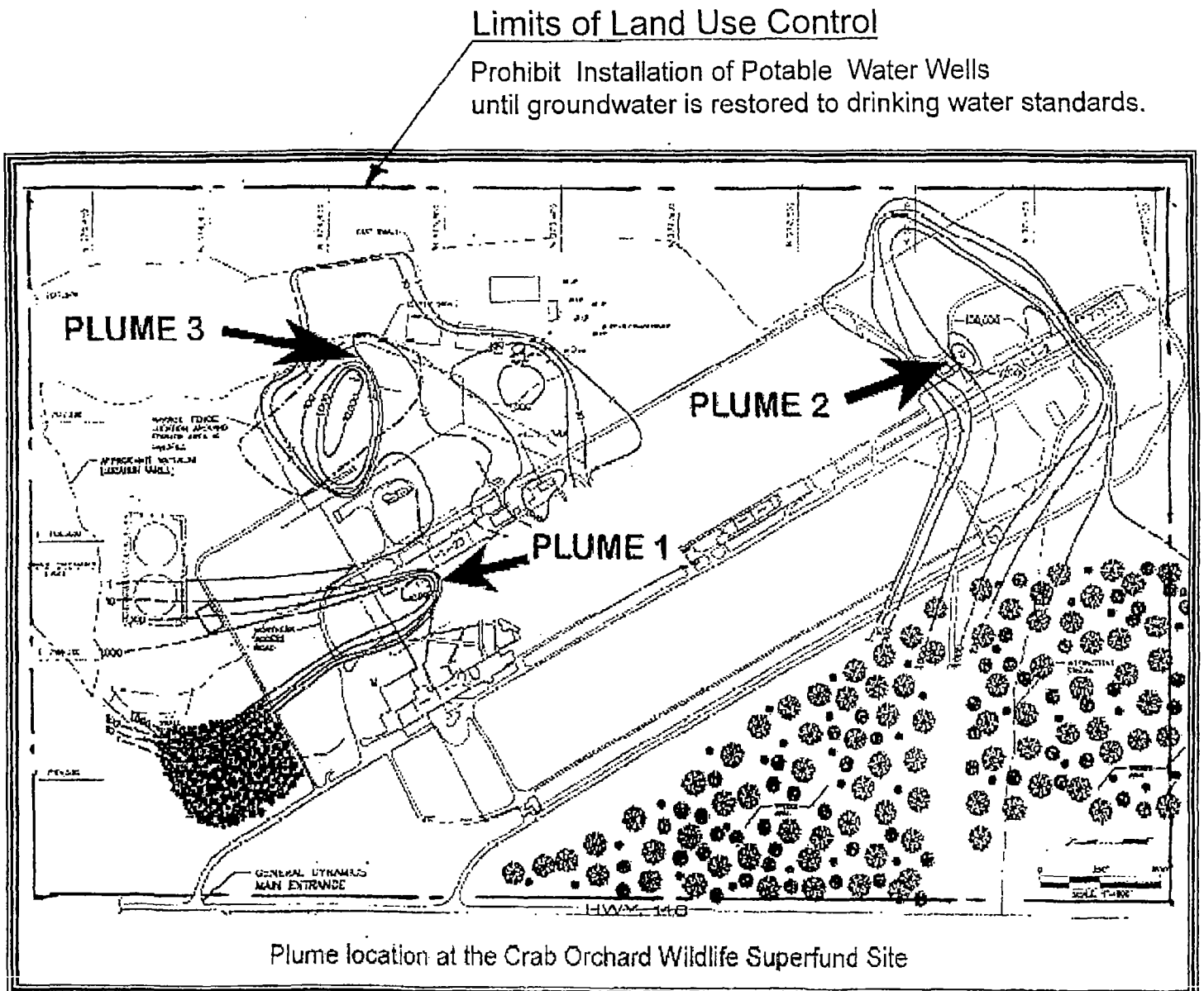
NOTE:
1. REFUGE BOUNDARY LOCATION APPROXIMATE.

SITE PLAN

3 0 3

SCALE IN MILES

CLIENT/PROJECT							TITLE
W-C/CRAB ORCHARD RI/IL							REFUGE LOCATION MAP
DRAWN	CHECKED	REVIEWED	DATE	SCALE	FILE NAME	JOB NO.	DWG NO.
TPK	W6B	W6B	2-23-94	AS SHOWN	8168109	933-8168	FIGURE 1



Plume location at the Crab Orchard Wildlife Superfund Site

Figure 2

APPENDIX A

RESPONSIVENESS SUMMARY FOR THE AMENDMENT TO THE RECORD OF DECISION FOR THE PCB AREAS OPERABLE UNIT
CRAB ORCHARD NATIONAL WILDLIFE REFUGE SUPERFUND SITE

This Responsiveness Summary summarizes the public comments U.S. EPA received regarding the Proposed Plan for the Amendment to the Record of Decision (August 1990) and the Explanation of Significant Differences (ESD) dated June 23, 2000 and U.S. EPA's responses to those comments. The Proposed Plan was released to the public on April 5, 2006, and the public comment period ran from April 5, 2006 through May 19, 2006.

The United States Environmental Protection Agency (U.S. EPA) received a total of five (5) public comments during the public comment period. Copies of all the comments received are included in the Administrative Record for the Site. U.S. EPA carefully considered all comments prior to selecting the remedies documented in the ROD Amendment.

Three of the commenters expressed support for the remedies selected by U.S. EPA. The remaining two commenters including Schlumberger Limited (Schlumberger) and General Dynamics Ordnance and Tactical Systems (GDOTS) submitted letters with detailed comments on the preferred remedies identified in the Proposed Plan. These comments fell within several different categories: basis for asserting the potential future groundwater use for drinking water purposes, uncertainty in estimating timeframes for bringing groundwater to drinking water standards, use of Alternative concentration limits, technical impracticality waiver, use of innovative technologies, evaluation of remedial alternatives using the nine criteria set forth in the NCP, and safety issues in implementing the remedy for Plume 2. This Responsiveness Summary does not repeat verbatim each individual comment. Rather, the comments are summarized and grouped by the type of issue raised. Comments regarding Plume 2 are not discussed because although the Proposed Plan discussed Plume 2, this amendment will not select a remedy for Plume 2. A separate ROD amendment later will be issued for Plume 2.

Comments from GDOTS:

GDOTS expressed concerns regarding the preferred remedy's potential impacts on GDOTS business operations, the efficacy of shoring and side slope support for excavation and the possibility that unexploded ordnance may be present. GDOTS' concerns are summarized below.

Plume 1

- Physical disruption during excavation, earth vibration (during shoring/sheet pile installation, excavation/well and piping installation, and backfill compaction) including destinations of underground utilities;
- Potential future subsidence of backfill and as a result of "heaving" sand (where the Upper Sand is exposed) during excavation;
- Disruption to operations during construction and operation of the treatment building;

- Future subsidence due to settlement resulting from long-term dewatering; and
- Security issues pertaining to having non-GDOTS personnel in proximity to GDOTS' energetic operations (this is also an issue for the Plume 2 area)

In addition, GDOTS raised the following:

- As described above, the associated volume of removed soil as described in the FS confirms that the excavations will have vertical side slopes. Although much of these excavations will be in cohesive soils, the proposed depths will require shoring or sheet piles to prevent unstable side slopes. Additionally, much of the excavated areas include fill from the earlier PCB excavations, which will be unstable if steep slopes are proposed. Alternatively, the side slopes should be inclined at least 2:1, which would require expansion of the overall footprint; and,
- GDOTS also is concerned that DOD may not have yet investigated whether unexploded ordnance is present in the areas where excavation activities are going to occur. The history of the munitions manufacturing operations at these affected areas predates GDOTS use of this site.

GDOTS requested that U.S. EPA respond to each of these technical issues to mitigate safety concerns and to ensure that there is no interruption in GDOTS business operations at the site.

U.S. EPA's Response: Most of the conditions that underlie the concerns raised by GDOTS' issues also existed during Schlumberger Limited's (Schlumberger) excavation and construction work in 1996-1997 as part of the PCB OU cleanup activities. Throughout the nearly two-year effort, Schlumberger worked cooperatively with Olin Corporation/Primex Technologies, predecessors to GDOTS, to minimize disruptions to business operations and ensure plant security. During construction of the contaminated material storage buildings, incineration unit and the water treatment building, the high level of cooperation between Schlumberger and Olin Corporation/Primex Technologies prevented disruption to business operations. Schlumberger's contractors took appropriate engineering measures and were able to excavate to depths exceeding 18 feet without disrupting normal business operations. Schlumberger will prepare a remedial action implementation plan (RAIP) which will address in greater detail these engineering issues raised by GDOT. The RAIP will determine the appropriateness of providing shoring or sheet piles, the design of the side slopes for the excavation areas, as necessary, and will address any other issues raised by GDOTS regarding the implementation of the selected remedy. U.S. EPA will review and approve the RAIP to ensure that GDOTS' concerns are adequately addressed prior to the start of actual cleanup work.

Security Measures

Schlumberger and Olin Corporation/Primex Technologies also cooperated on security issues during the 1996-1997 PCB OU cleanup activities and again during the later groundwater investigation at the site to allow specified non-GDOTS personnel access to the potentially contaminated areas near Buildings I-1-23, I-1-2, I-1-3, and I-1-36. Since GDOTS took over the operations at the Crab Orchard Site, Schlumberger and its contractors collected air monitoring samples inside Buildings I-1-2 and I-1-3 which are currently being used by GDOTS for

warehousing raw materials and/or finished products. U.S. EPA, Illinois EPA, and FWS personnel have entered these buildings for inspection without encountering significant security issues. U.S. EPA appreciates the coordination extended to the agency staff and Schlumberger's contractor staff on numerous occasions.

U.S. EPA expects that a limited number of contractor personnel, vendors, and workers would be allowed access for performing the cleanup activities. The security screening of these non-GDOTS personnel will be resolved during the remedial design phase prior to the actual start of remedial action. These access issues and security issues are important yet manageable matters.

In addition, GDOTS itself is performing a Remedial Investigation at a number of sites/locations within many areas currently occupied by GDOTS. U.S. EPA believes that access and security issues for workers are similar to both activities.

Unexploded Ordnance

Throughout the potentially contaminated areas, Schlumberger's contractors have installed numerous monitoring wells and geoprobes without any major issues and did not encounter unexploded ordnance (UXO). Prior to start of the cleanup work, however, U.S. EPA will confirm with the Department of the Army (Army) that there are no unexploded ordnances at or near all areas needing remediation. If the Army indicates that there may be UXOs in any of the affected areas, U.S. EPA will require the Army to identify and remove the UXOs before the remedy is implemented. The necessity to demolish certain unused buildings on the eastern side of Building I-1-3 will be determined during the remedial design phase. If necessary, these buildings would be demolished as part of the remedial action.

As explained above, the RAIP will address the security issues raised by GDOTS. U.S. EPA will review and approve the RAIP to ensure that GDOTS' concerns are adequately addressed prior to the start of actual cleanup work.

Schlumberger and its consultants will determine the appropriateness of providing shoring or sheet piles, and design the side slopes for the excavation areas, as necessary, and will prepare a remedial action implementation plan (RAIP) which will address all issues relating to the cleanup activities, including issues raised by GDOTS. U.S. EPA will review and approve the RAIP to ensure that GDOTS' concerns are adequately addressed prior to the start of actual cleanup activities.

Comments from Schlumberger:

Schlumberger's Comment: The selected remedy must be based on site-specific conditions and risk and assertion that the groundwater will be used in the future for drinking water does not reflect site specific factors.

U.S. EPA's Response: U.S. EPA generally defers to State Groundwater Classifications for current or future groundwater uses. The contaminated aquifer at Sites 32/33 of the PCB OU,

however, has been classified by the State of Illinois as a Class I Potable Resource Groundwater in accordance with Illinois Administrative Code, Title 35, Part 620, Subpart B (Section 620.210). The definition of "resource groundwater" is found in the Illinois Groundwater Protection Act, "a resource groundwater means a groundwater that is presently being or in the future capable of being put to beneficial use" (415 Illinois Compiled Statutes (ILCS) 55/3(j)).

The Illinois Pollution Control Board (IPCB) states in its Final Opinion and Order on Section 620.210, "the Board believes that among the most necessary facets of the State's groundwater protection program is the need to protect all drinkable water at a drinkable level. Similarly, the Board does not believe that current actual use should be the sole control of whether potable groundwater is afforded the same protection necessary to maintain potability; we simply cannot allow the sullying of a resource that future generation may need." The IPCB's opinion comports well with the NCP's expectation to return usable groundwaters to their beneficial uses wherever practicable (40 CFR 300.430(a)(1)(iii)(F)). Accordingly, Illinois EPA and U. S. EPA affirm the need to protect the potential future beneficial use of the Sites 32/33 Class I Potable Resource Groundwater by virtue of the remedies contained in this ROD Amendment. Therefore, MCLs are relevant and appropriate for the groundwater remediation at the site.

Groundwater at this site is contaminated with TCE and other chlorinated solvents well above MCLs and Illinois Class I Groundwater Standards. Use of the groundwater at Sites 32/33 of the PCB OU as a drinking water resource is a reasonably anticipated future use and would pose unacceptable risk.

Schlumberger's Comment: The proposed plan presents an estimate of time that each alternative would take to remediate each source area as if that time were a specific value that is known with a high degree of accuracy.

Schlumberger contends that the time projections in the FFS - Rev. 3 were created through use of the groundwater model developed for the site. The modeling estimates include a large degree of uncertainty. As discussed in Section 7 of the FFS - Rev. 3, "...[s]imulations of the remedial alternatives for each CVOC source area and plume "should be considered as a 'semiquantitative' evaluation, and predicted concentrations should be considered in a relative, rather than an absolute, sense." The estimates of the length of time needed to remediate each area rely on estimates of the source mass (and particularly the mass of non-aqueous phase liquids, or "NAPL"), its form (residual coatings, blebs, ganglia, or pools), the location of the source (in permeable sands, low permeability clays, etc.), biodegradation rates, and groundwater flow rates. These parameters have substantial variability over a site such as the PCB Operable Unit, and are almost never known with a high degree of certainty.

Schlumberger contends that the time projections include too much uncertainty to support the conclusions in the Proposed Plan and there is a possibility that none of the alternatives would ever attain MCLs. Based on uncertain ability of the various alternatives to remove NAPL mass and reduce groundwater concentrations to specified level, Schlumberger contends that the differences among the remedial alternatives are likely minor, and the predicted shorter remediation period based on the projections in the FFS cannot justify a significantly greater remediation effort or cost. Schlumberger also commented that the bulk of the estimated time to

move from levels which would provide full protection of human health and the environment at this site (e.g., 30 to 40 ppb) to much lower levels (MCLs) that are not relevant and appropriate for this site.

U.S. EPA's Response: Generally at groundwater remediation sites, the timeframes to bring the groundwater to the desired cleanup levels are based on site-specific groundwater modeling results. These modeling results nearly always have some degree of uncertainty and are estimates only. U.S. EPA agrees that there are uncertainties in the groundwater modeling conducted by Schlumberger with regard to several factors including actual mass of NAPL residuals, the form of NAPL, and the achievable removal effectiveness of various remedial alternatives. The timeframes and predicted concentrations discussed in the ROD Amendment are based on modeling results and are considered in a relative, rather than an absolute sense.

It is possible that some or most of the NAPL may already have been removed. During the PCB remedial action in 1996, a large volume of PCB-contaminated soil within the TCE source area was remediated. Schlumberger did not adjust its model to reflect that possibility but made reasonable, yet conservative, assumptions in calibrating the transport model to represent the source areas. Appendix B of the Focused Feasibility Study (FFS) Report (Rev. 3) discusses the rationale for the assumptions made in the calibration of the groundwater model. Based on the iterative process of calibration of the model to measure concentrations in the plume, constant-concentration nodes were set at 20,000 µg/L TCE for the Upper Clay and Upper Sand units at the Building I-1-23 area and the Repository. For Buildings I-1-2/I-1-3 source areas, constant concentration nodes were set at 100,000 µg/L TCE in the Upper Clay, and 30,000 µg/L TCE in the Upper portion of the Lower Clay. Page B-5 (Appendix B) of the FFS Report states that these constant-concentration values were chosen based on the adjustments made during calibration to reproduce the observed concentrations in the aquifer, and do not take into account removal of source materials during the PCB remedial action in 1996. The report further states that the calibration of the transport model to measured values that exist in the aquifer is considered appropriate and representative of a system that is in quasi-equilibrium with the remaining source area TCE residuals. U.S. EPA believes that the FFS prepared by Schlumberger used reasonable, yet conservative assumptions in its input to the groundwater model.

As stated earlier, MCLs are relevant and appropriate for the groundwater remediation at the site. U.S. EPA disagrees with Schlumberger's contention that the differences among the remedial alternatives are likely minor and that the predicted shorter remediation period based on the projections in the FFS cannot be used to justify a significantly greater remediation effort or cost. Based on the modeling results, there are significant differences in timeframes between Alternative A2 (approximately 40 years) and all of the other alternatives (approximately 75 years for Alternative G and more than 200 years for all other alternatives) for Plume 1. In addition, as stated in Section 7.3.1 of the FFS Report, because of the broad effect of groundwater extraction, the effects of uncertainties (e.g., uncertainties in the modeling, in the effectiveness of groundwater extraction, and in the location and quantity of source material) on the projections of groundwater quality over time are expected to be relatively small compared to the effects of uncertainties on some other remedial alternatives. The effects of uncertainties associated with Alternative A2, which includes both excavation and groundwater extraction and treatment are

relatively small when compared with other alternatives which do not include groundwater extraction.

One of the remedial action objectives is to restore groundwater to drinking water standards to the extent practicable. Alternative A2 for Plume 1 is expected to meet this objective within an estimated timeframe of 40 years, respectively, when compared to most of the other alternatives which take more than 200 years to achieve the same objective.

Schlumberger's Comment: ACLs may be used if the conditions of CERCLA Section 121(d)(2)(B)(ii) are met and cleanup to MCLs or other protective levels is not practicable. If these statutory criteria for ACLs, including a finding that active restoration of the ground water to MCLs or non-zero MCLGs is deemed not to be practicable, documentation of these conditions for the ACL is sufficient and additional documentation of a waiver of the MCL or MCLG is not necessary.

U.S. EPA's Response: Although the alternatives that include ACLs are viable remedial alternatives, U.S. EPA chose Alternative A2 over alternatives that use ACLs, because modeling predicts that active restoration of the groundwater to MCLs is practicable. Under Alternative A2, excavation to 1 mg/kg VOC contour in the Upper Clay unit is expected to remove most of the VOCs, including NAPLs. Based on the model predictions, groundwater extraction and treatment in the upper sand unit would remove all of the NAPLs in approximately 10 years. Remaining NAPLs in the Upper Clay unit would be removed in approximately 14 years. Groundwater would be restored to MCLs in about 40 years.

U.S. EPA agrees with Schlumberger that ARAR waivers are not necessary where ACLs are used. The ROD Amendment corrects this inaccuracy.

Schlumberger's Comment: If MCLs continue to be used as ARARs, U.S. EPA should provide a technical impracticability waiver of the MCLs as authorized by the NCP and EPA guidance.

U.S. EPA's Response: U.S. EPA acknowledges that the presence of NAPLs in the source area presents significant limitations on the potential effectiveness of remedial alternatives and results in lengthy time periods required to achieve groundwater cleanup standards. Based on the groundwater modeling results, the time required to achieve groundwater cleanup standards for most of the alternatives (with the exception of Alternatives 2 and G for Plume 1) is more than 200 years. However, U.S. EPA believes that where the contaminated groundwater is not currently used or an alternate water source is readily available, and there is no near-term future need for the resource, it is appropriate to consider a longer time frame for achieving restoration cleanup levels. For the Crab Orchard Site, the timeframe of 40 years for Plumes 1 to restore the groundwater to beneficial use is considered reasonable. Technical Impracticality Waiver at this site is not currently being considered since restoration of the groundwater to MCLs is not impracticable.

Schlumberger's Comment: Schlumberger suggests that the ROD Amendment include a language that would allow further consideration of innovative technologies.

U.S. EPA's Response: U.S. EPA is receptive to viable innovative technologies as long as Schlumberger demonstrates that such new technologies are appropriate for this site. Additional language in the ROD Amendment is not necessary.

Schlumberger's Comment: For Plume 1, Schlumberger suggests the selection of either Alternative F or even Alternative A1 at a substantially lower cost and with correspondingly greater cost-effectiveness.

U.S. EPA's Response: Both Alternatives A1 and F involve the excavation of contaminated soil in the Upper Clay unit to only 10 mg/kg VOC contour. Although Alternatives A1 and F cost 21% and 40%, respectively, less than Alternative A2, these alternatives would leave a substantial mass of VOCs and NAPLs remaining in the Upper Clay resulting in this alternatives taking more than 250 years to restore the groundwater to MCLs which are relevant and appropriate requirements for this site. Alternative A2 would restore the groundwater to MCLs throughout the plume area within a timeframe of about 40 years. As stated earlier, the effects of uncertainties associated with Alternative A2 which includes both excavation and groundwater extraction and treatment are relatively small when compared with Alternative F. U.S. EPA is justified in selecting Alternative A2 over Alternatives A1 and F.

Schlumberger's Comment: Comments on Evaluation Criteria for Plume 1

U.S. EPA's Response: Schlumberger's comments are based on its assertion that there is no basis to bring groundwater to MCLs, uncertainties in the predicted concentrations and timeframes, and its assertion that ACLs, rather than MCLs are relevant and appropriate.

As stated earlier, MCLs are relevant and appropriate for the groundwater remediation at this site. For Alternative 2 that includes both excavation and groundwater extraction and treatment, the effects of uncertainties on the projections of groundwater quality are relatively small when compared with other alternatives which do not include groundwater extraction.

Schlumberger commented that some of the comparisons made in the Evaluation of Alternatives Section of the Proposed Plan are either incorrect or misleading in its opinion. In order to address their concerns, U.S. EPA has revised the section on the Evaluation of Alternatives. This is reflected in the Evaluation of Alternatives Section of the ROD Amendment.

Schlumberger's Comment: The Proposed Plan includes an element that nullifies even the purported benefits of Alternative A2. As noted above, under the Proposed Plan, U.S. EPA will re-evaluate in five years whether removal of the CVOC mass (particularly NAPL) from the Upper Sand zone will take significantly longer than 11 years. If it will, U.S. EPA may halt further groundwater extraction at the five-year point and issue a technical impracticability waiver. If this occurs, active remediation of the Upper Sand will cease as soon as the pump-and-treat system is shut off. Substantial amounts of CVOC source mass would remain in the Upper Sand, and TCE concentrations would persist, perhaps for many decades, throughout the plume at levels potentially several orders of magnitude greater than MCLs. Conversely, under Alternative F, the TCE concentrations in groundwater near the lake are predicted to approach the MCL after 30 to 40 years, with concentrations throughout the plume continuing to decrease gradually as the

CVOC source mass that may remain in the Upper Clay is depleted. Given the possibility (or even the likelihood) of a technical impracticability waiver after five years, Alternative A2 could leave the aquifer worse off than under Alternative F. The bio-substrate periodically injected into the Upper Sand up to a 5-year period under Alternative F would continue to provide active biological treatment of the remaining CVOC source mass long after the injections ceased.

U.S. EPA's Response: U.S. EPA will evaluate the progress of the remedy in achieving groundwater remediation five years after the start of the groundwater extraction and treatment. U.S. EPA's willingness to evaluate the progress does not automatically mean that a TI waiver is imminent. Depending on its evaluation, U.S. EPA may recommend additional enhancement to the chosen remedy or continuing the groundwater extraction process beyond the 11 years originally predicted by the model results or consider TI waiver, if appropriate. We disagree with Schlumberger's assertion that Alternative A2 could leave the aquifer worse off than under Alternative F. Because of the excavation (to 1 mg/kg VOC contour) component of the remedy for Alternative A2, almost all of the NAPL mass in the Upper Clay unit would be removed during the excavation phase in the Upper Clay unit and the remaining NAPL mass in the Upper Clay unit would be removed in approximately 14 years, whereas for Alternative F (excavation to 10 mg/kg only) the model predicts that it would take approximately 250 years to remove all of the NAPL mass from the Upper Clay unit. Please note that uncertainties associated with remedies that include groundwater extraction are relatively small compared with other alternatives such as Alternative F. Even if it took substantially longer timeframe than 14 years to remove the principal threat (NAPL mass in the Upper Clay Unit) and longer than 10 years to remove all of the NAPL in the Upper Sand unit, Alternative A2 is still the better remedial alternative than either Alternatives A1 or F.

Schlumberger's Comment: The Proposed Plan indicates on Page 20 that "Alternatives A1 and A2 provide the greatest likelihood that the mobility of the contaminants would be reduced because any groundwater contamination remaining after source removal would be captured by groundwater extraction wells." This statement is incorrect. The extraction well that would pump groundwater from the Upper Sand unit following the Upper Clay excavation would capture contaminants (VOCs) only within the hydraulic capture zone of the well. The extraction well would be located within the Building 1-1-23 source area. The VOCs in the groundwater plume outside of the capture zone would not be captured by the extraction system.

U.S. EPA's Response: Based on the Groundwater flow modeling, a single vertical extraction well screened in the confined Upper Sand unit at the location of the highest VOC concentrations in the source area would effectively cut off and remove dissolved VOCs migrating from the source area in groundwater. A single well is expected to establish a hydraulic capture zone of approximately 900 feet wide at the source area well location. The number and location of the extraction wells (if more than one well is needed) will be established during the remedial design phase to ensure that groundwater contamination remaining after source removal would be effectively captured.

Schlumberger's Comment: Alternative F would cost 40% less than Alternative A2, and Alternative A1 would cost 24% less than Alternative A2. Alternative A2 requires the excavation and offsite disposal of significantly more contaminated soil than Alternative F or Alternative A1, but does not provide any greater protection of human health and the environment at this site (i.e.,

any greater reduction of site-specific risks) than either Alternative F or Alternative Al. Because Alternatives F and A1 provide protection of health and the environment, achievement of ARARs, long-term effectiveness, short-term effectiveness, and implementability at substantially lower costs than Alternative A2, no basis exists under CERCLA or the NCP to require expenditure of the higher cost of Alternative A2, and selection of Alternative A2 would be arbitrary and capricious.

U.S. EPA's Response: As stated earlier, groundwater at this site is contaminated with TCE and other chlorinated solvents well above MCLs and Illinois Class I Groundwater Standards. Future use of the groundwater at Sites 32/33 of the PCB OU as a drinking water resource would pose unacceptable risk. Alternative A2 would bring the groundwater to MCLs within an estimated timeframe of 40 years, while Alternatives A1 and F would take longer than 250 years. Hence the higher cost for Alternative A2 is justified by the more reasonable remediation timeframe.

Schlumberger's Comment: On page 11, the Proposed Plan states: "Concentrations of VOCs on the order of 66,000 ppb extend in the groundwater plume from the Building 1-1-23 source area northward (downgradient) to Crab Orchard Lake." This statement is incorrect. VOC concentrations at the noted concentration range have only been detected in the immediate VOC source area. VOC concentrations observed in groundwater samples from monitoring wells outside the immediate source area are substantially lower than the indicated concentration range.

U.S. EPA's Response: The ROD Amendment addresses this concern by stating that concentrations of VOCs on the order of 3,000 ppb extend in the groundwater plume from Building I-1-23 source area northward to Crab Orchard Lake.

Schlumberger's Comment: The FWS has expressed a preference for Eastern Cottonwood as the tree species that best suits the requirements of the Refuge, rather than poplars. Final selection of the species of trees to be used should be made during the remedial design phase, rather than specified in a ROD Amendment.

U.S. EPA's Response: The ROD Amendment addresses this concern by including Eastern Cottonwood as one of the tree species under the Phytoremediation component of the remedy.

Schlumberger's Comment: The Proposed Plan presumes that a sufficient number of additional soil and groundwater samples can be collected (presumably from the Upper Sand unit) to allow use of the existing groundwater model to develop "a more accurate time frame" to reach MCLs at all locations. The key factors that will affect the actual time required to reach MCLs are the amount of VOC source mass that remains in the Upper Sand and the effectiveness of VOC source mass removal from the Upper Clay. As demonstrated by the results of the many soil and groundwater samples that have been collected in the Building 1-1-23 source area, the ability to develop an accurate estimate of the actual amount of VOC source mass remaining from such sampling is extremely difficult (if not impossible), given the physical conditions at this source area. It is unlikely that the additional sampling required by the Proposed Plan will allow the development of remediation time frame estimates that are any more accurate than the estimates already provided in the FFS - Rev. 3. The accuracy of the groundwater model in projecting the total time required to reach MCLs will still primarily depend on the accuracy of the estimate of

total VOC source mass remaining – and little, if any, improvement in the accuracy of that mass estimate is likely to be provided by the required additional soil and groundwater sampling. Therefore, there is no technical basis for requiring the additional burdens and costs of this future sampling.

U.S. EPA's Response: Following completion of the excavation component of the remedy, confirmative samples will be taken to verify that the cleanup criteria are met. In addition, groundwater samples are needed to establish baseline conditions prior to the start of any groundwater extraction and treatment. Collection of these samples is required as part of the remediation. If there are no significant differences between the new data collected and the previous data input into the groundwater model, no further modeling may be necessary. The data obtained from the future groundwater sampling will be used to ultimately determine the progress of the remedy.

ATTACHMENT B

UNITED STATES DISTRICT COURT FOR THE
SOUTHERN DISTRICT OF ILLINOIS

UNITED STATES OF AMERICA, Plaintiff, vs. SCHLUMBERGER INDUSTRIES, INC., Defendant.	CIVIL ACTION NO. 91-4222

FIRST MODIFICATION TO APPENDIX 2
SCOPE OF WORK FOR REMEDIAL DESIGN / REMEDIAL ACTION
PCB AREAS OPERABLE UNIT
CRAB ORCHARD NATIONAL WILDLIFE REFUGE, CARTERVILLE, ILLINOIS

November 2010

I. PURPOSE

The purpose of this Remedial Action at the PCB Areas Operable Unit of the Sangamo Electric Dump / Crab Orchard National Wildlife Refuge Superfund site ("Site" or "Refuge") is to protect human health, welfare, and the environment in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act, as amended ("CERCLA"), and the National Contingency Plan. The Remedial Action Plan is embodied in the Record of Decision ("ROD") for the PCB Areas Operable Unit ("PCB OU"), which was signed by the United States Environmental Protection Agency ("U.S. EPA") on August 1, 1990 and amended by U.S. EPA and the United States Department of the Interior ("DOI") in May 2007 ("ROD Amendment"). This Scope of Work ("SOW") describes certain tasks to be completed by Schlumberger Technology Corporation ("Settling Defendant") to address contaminated soil and groundwater within portions of the PCB OU. The U.S. EPA Superfund Remedial Design and Remedial Action Guidance, the ROD, ROD Amendment, and the approved Remedial Design/Remedial Action Work Plan, any additional guidance timely provided by U.S. EPA, and this SOW shall be followed in performing the tasks set forth herein.

II. DESCRIPTION OF THE REMEDIAL ACTION

The selected remedies for contaminated groundwater contained within the PCB Areas Operable Unit, as discussed in the ROD and ROD Amendment, address three major groundwater plumes at Sites 32/33, identified as follows:

1. Groundwater Plume near Building I-1-23 ("Plume 1");

2. Groundwater Plume near Buildings I-1-2/I-1-3 ("Plume 2");

3. Groundwater Plume beneath the Area 9 Repository ("Plume 3").

Although Plume 2 was historically evaluated in conjunction with Plumes 1 and 3, in response to safety concerns raised by the U.S. Fish & Wildlife Service ("FWS"), U.S. EPA will separately address Plume 2.

The selected remedies include source removal through excavation and off-site disposal of contaminated soil, extraction and treatment of contaminated groundwater, phytoremediation of contaminated groundwater, and remediation of contaminated groundwater through natural attenuation processes. The source materials identified as the principal threats are soil and groundwater contaminated with chlorinated volatile organic compounds ("CVOCs"), most notably trichloroethylene ("TCE"). Contaminants occur mainly within the Upper Clay and Upper Sand units; groundwater within the underlying Lower Clay and Lower Sand units generally shows nondetectable concentrations of contaminants.

The major components of the remedies for Plumes 1 and 3 are:

1. Plume 1: Excavation and Off-site Disposal of CVOC-contaminated~~;~~ Soil to 1 mg/kg CVOC contour in the Upper Clay unit, Groundwater Extraction and Treatment in the Sand unit beneath the Upper Clay, and Phytoremediation.

2. Plume 3: Phytoremediation and Monitored Natural Attenuation ("MNA").

3. Institutional Controls to prohibit the installation of potable water wells until the groundwater is restored to the drinking water standards.

Groundwater Plume near Building I-1-23 (Plume 1)

As detailed in the ROD Amendment, CVOC-contaminated soil in the vicinity of Building I-1-23 shall be excavated to the 1 mg/kg CVOC contour in the Upper Clay Unit. The purpose of this excavation is to remove most of the non-aqueous phase liquids ("NAPLs") in the Upper Clay unit. After the excavation component of the remedy is complete, additional soil and groundwater samples will be collected to establish new baseline conditions at the Site. The new data will be used in conjunction with groundwater models to refine the anticipated time frame for achievement of Maximum Contaminant Levels ("MCLs") under the Safe Drinking Water Act. An extraction well system will be designed and installed to remove dissolved CVOC source area mass from the Upper Sand unit. Groundwater extraction is expected to continue for a period of approximately 11 years, at which point most of the NAPL mass is expected to be removed in the Upper Sand unit.

The Phytoremediation component of this selected remedy includes the planting of phreatophytic trees, including poplar, willow, or Eastern Cottonwood trees, near Crab Orchard Lake for phytoremediation of the shallow groundwater. These trees uptake TCE and other CVOCs and degrade them to several known metabolic products, such as trichloroethanol, trichloroacetic acid, and dichloroacetic acid. Final selection of the species of trees to be used will be made during the Remedial Design phase. The purpose of the Phytoremediation is to reduce the volume of contaminated groundwater and the mass of CVOCs discharging to Crab Orchard Lake or other surface water locations by slowing down or reversing shallow groundwater flow toward the drainage swales and the lake and by phytotransformation of the CVOCs. Institutional Controls shall be implemented to prohibit the installation of potable water wells until the groundwater is restored to drinking water standards.

Groundwater Plume Beneath the Area 9 Repository (Plume 3)

As detailed in the ROD Amendment, the Phytoremediation component of this selected remedy includes the planting of phreatophytic trees as described above for Plume 1. The purpose of the Phytoremediation for Plume 3 is the same purpose for use of Phytoremediation

for Plume 1. In addition to the descriptions above, the MNA component of the selected remedy includes regular periodic monitoring of groundwater and surface water to assess the attenuation of contaminant plumes via natural chemical, physical, and biological processes. The monitoring data shall be evaluated to determine if the groundwater contaminant plumes are stable or receding, and to determine the rate of change of the CVOC concentrations. Institutional Controls shall be implemented to prohibit the installation of potable water wells until the groundwater is restored to drinking water standards.

The above actions, as required in the ROD Amendment, shall be designed to meet the following Cleanup Standards and Performance Standards.

III. CLEANUP STANDARDS

The Remedial Action shall meet or exceed all of the Cleanup Standards for the sites addressed in this SOW, as established in the ROD Amendment. The Cleanup Standards for these sites are discussed briefly below.

A. SOIL

Contaminated soil in the vicinity of the Plume 1 source area shall be excavated to the 1 mg/kg CVOC contour in the Upper Clay unit, as identified in Figures 4-16 and 4-17 of the Preliminary Design Report (RMT, May 2001). All of the 1990 ROD requirements for the PCB OU shall also be met.

B. GROUNDWATER

Contaminated groundwater at the study sites selected for extraction and treatment (Plume 1) and MNA (Plume 3) will be remediated to MCLs for the contaminants of concern. All Applicable or Relevant and Appropriate Requirements ("ARARs") described in the ROD and ROD Amendment will also be met.

IV. PERFORMANCE STANDARDS

The Remedial Action shall meet or exceed and otherwise comply with all of the Performance Standards necessary for implementation of the selected remedy in the ROD Amendment. The Performance Standards include those outlined below and all ARARs specified in the ROD and ROD Amendment.

A. SOIL

1. CVOC Contaminated Soil

Soil within the 1 mg/kg CVOC contour in the Upper Clay unit shall be excavated and disposed off-site. Excavated soil shall be tested for the characteristic of leachability (40 C.F.R. § 261.24) using the currently approved testing methodology at the time of the analysis (i.e., TCLP) and properly disposed at an appropriate off-site landfill. Excavation backfill materials will be sampled to ensure they are free of contamination.

2. Air

Certain potential risks may occur from inhalation of contaminants from existing Site conditions or the Remedial Action. Air quality in work zones during excavation of the contaminated soil and during backfilling of the excavated areas shall be monitored to ensure that contaminant levels do not exceed any of the ARARs established in the ROD. If air emissions exceed these levels, corrective measures shall be undertaken, as developed in the Site Safety Plan.

B. GROUNDWATER

1. Pre-Design Groundwater Monitoring

During pre-design sampling, the integrity of the existing groundwater monitoring wells shall be evaluated. Groundwater sampling shall be conducted from the wells which are determined to be useful (or additional or replacement wells, if any) with sample analysis for CVOCs and other relevant parameters to characterize current groundwater conditions. For Plume 3, the final number and locations of necessary groundwater monitoring wells will be determined during design. In addition, previous hydrogeologic assessments of the study areas shall be updated to the extent necessary to support the Remedial Design. The updating of such assessments, in conjunction with the Remedial Investigation and subsequent data, shall include the establishment of background contaminant levels for naturally occurring constituents and current levels of indicator parameters. Implementation details for the Pre-Design Groundwater Monitoring program are to be included in the Pre-Design Work Plan.

2. Post-Excavation Groundwater and Soil Sampling

The purpose of Post-Excavation Groundwater and soil sampling is to establish new baseline conditions for groundwater quality, following completion of the removal of overlying contaminated soil, in order to assess future improvements in groundwater quality. The data will also be evaluated to determine whether historical assumptions related to the extent of contamination, contaminant fate and transport, and other variables remain valid. The new data

will be input into the groundwater model to arrive at a more refined time frame for bringing groundwater to MCLs.

3. Remedial Action Construction/Implementation

The purpose of monitoring during the construction and implementation of the Remedial Action is to ensure compliance with approved plans, and to determine that standards and ARARs are being met. The actual monitoring programs(s) will depend on the specific component of the Remedial Action and shall be determined during the Remedial Design. Samples shall be collected from the appropriate remedy component, with the final frequency established during design. Each sample shall be analyzed for CVOCs and other constituents of concern identified during design to ensure all applicable remedial and health and safety criteria are met.

4. Groundwater Monitoring During Groundwater Extraction and Treatment

The purpose of Groundwater Monitoring During Groundwater Extraction and Treatment is to ensure the effectiveness of the Remedial Action by establishing that the source removal from the contaminated area near Building I-1-23 has sufficiently reduced the contribution of remaining CVOC source mass to groundwater contamination and to stabilize or abate, if necessary, existing conditions. Sampling will also allow for the assessment of the attenuation of contaminant plumes via natural chemical, physical, and biological processes, following completion of the removal of overlying contaminated soil. The actual monitoring system(s) shall be determined during Remedial Design and shall be based on historical data and the results of the pre-design groundwater sampling and analysis. Samples and measurements from the monitoring network shall be collected quarterly during the first year of monitoring, followed by a minimum of twice per year until the first five-year review. Each sample shall be analyzed for parameters that will be determined during design.

5. Treated Groundwater

Effluent from the Groundwater Extraction and Treatment System will be monitored during operation of the system. The purpose of effluent monitoring is to ensure that the treated groundwater does not exceed applicable discharge criteria. The actual monitoring program(s) shall be determined during Remedial Design. Samples shall be collected from sampling locations approved during design, with the final frequency established during design. Each sample shall be analyzed for CVOCs and other parameters that may be determined to be necessary during design to ensure discharge criteria are met.

If during the startup phase, contaminant concentrations in the Groundwater Treatment System influent, mid-train, or effluent exceed target treatment or applicable discharge criteria, corrective measures shall be undertaken, as described in the Operation and Maintenance Plan.

6. Long-Term Groundwater Monitoring

Groundwater monitoring shall occur, as appropriate, to assess the long-term attenuation of Plumes 1 and 3 via natural chemical, physical, and biological processes. Long-Term Groundwater Monitoring requirements associated with Plumes 1 and 3 include:

- Plume 1: Long-Term Groundwater Monitoring shall occur following the successful shutdown of the Groundwater Extraction and Treatment System. The actual monitoring system design will be based on the results of previous monitoring phases. Samples shall be collected from the Plume 1 area twice per year following shutdown of the Groundwater Extraction and Treatment System, with the final frequency established during the Remedial Design. Each sample shall be analyzed for parameters as determined during the design.

- Plume 3: Long-Term Groundwater Monitoring shall occur following completion of the baseline sampling of groundwater monitoring wells in the Plume 3 area, and following U.S. EPA approval of the Sampling and Analysis Plan and the Pre-Certification Operation and Maintenance Plan. The actual monitoring system shall be determined during Remedial Design and shall be based on the results of the pre-design groundwater sampling and analysis. Samples and measurements shall be collected from the monitoring network quarterly during the first year of monitoring, followed by a minimum of twice per year until the first five-year review. Each sample shall be analyzed for parameters that will be determined during design.

Groundwater monitoring and evaluation of resulting data utilized in support of MNA determinations shall be performed in accordance with the ROD, the ROD Amendment, and the "Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites" (MNA Guidance) (Directive 9200.4-17P), or any amendments thereof.

V. SCOPE OF REMEDIAL ACTION

An outline of the Scope of the Remedial Action in its entirety, is set forth below. Settling Defendant shall implement Tasks 1 through 5.

A. Task 1: Pre-Design Work

1. Site Access
2. Quality Assurance and Quality Control
3. Safety Plan
4. Sampling and Analysis Plan - Groundwater & Soils

B. Task 2: RD/RA Work Plan Development

C. Task 3: Remedial Design

1. Design Phases
2. Excavation Plan
3. Construction Quality Assurance Plan
4. Operation and Maintenance Plan
5. Cost Estimate

D. Task 4: Remedial Action Implementation

1. Pre-construction Inspection and Meeting
2. Soils Excavation
3. Remedy Construction and Implementation
4. Pre-final Inspection
5. Final Inspection
6. Long Term Operation and Maintenance

E. Task 5: Schedule and Reporting

1. Monthly Progress Reports
2. Schedule
3. Operation and Maintenance Oversight Reports
4. Quarterly and Semiannual Groundwater Monitoring Reports
5. Five-Year Review Reports

A. TASK 1 - PRE-DESIGN WORK

This Remedial Action will require additional studies to supplement the available technical data. In order to adequately design the selected remedy and to aid in the implementation of the Remedial Action, certain pre-design work is required. These additional studies and pre-design work shall include, at a minimum, the tasks outlined below.

For the pre-design work outlined below and the studies required, the Settling Defendant shall furnish all services, including field work as required, materials, supplies, plant, labor, equipment, investigations, studies, and superintendence. Sufficient sampling, testing, and analysis shall be performed to design the required Remedial Action. Except as otherwise noted, the results of the pre-design work with the recommended design parameters shall be presented on or before the deadline in the approved Pre-design Schedule. Periodic meetings and review conferences will be held, as necessary, to review the progress of the pre-design work, discuss results and their impact on the Remedial Design, and identify and resolve issues.

No later than 60 calendar days after entry of the SOW, the Settling Defendant shall submit to U.S. EPA for review and approval a Pre-design Work Plan which describes in detail the studies to be performed and the guidelines and procedures to be used for obtaining and assessing the required information ("Pre-design Work Plan"). The plan shall include, as appropriate, a Sampling and Analysis Plan (including data management procedures), quality assurance and quality control procedures, and health and safety provisions. A schedule for performance of the pre-design work ("Pre-design Schedule") shall be submitted along with the Pre-design Work Plan. The results of the pre-design work shall be submitted in a Pre-design Report on or before the deadline established in the Pre-design Schedule and shall include all data collected, a summary of the results of all such studies, and a discussion of the design parameters which will be determined on the basis of the findings.

With respect to any Pre-design Work to be carried out at Area 9, the health and safety provisions shall incorporate, as much as practicable, and if available to the Settling Defendant: (1) the zones of exclusion established considering, among other concerns, the quantity / distance limitations regarding munitions manufacturing applicable to General Dynamics Ordnance and Tactical Systems ("GD-OTS") at the time of the work; (2) the pertinent substantive safety requirements set forth in Chapter 3 and, to the extent applicable, Chapter 10 of the DOD (Department of Defense) Contractors' Safety Manual for Ammunition and Explosives (DOD 4145.26-M); and (3) coordination with GD-OTS safety personnel of any work in areas within the quantity/distance limitations.

1. Site Access

All site access agreements required to implement the activities required by this SOW shall be obtained by the Settling Defendant, in accordance with Section X of the Consent Decree, prior to the initiation of the Remedial Action (including excavation) or additional studies. Site access shall extend for the duration of the construction and initial startup of the Remedial Action. Site access agreements relating to the operational phase of the Remedial Action following the initial startup, including all operation and maintenance considerations, are reserved for a subsequent modification to the SOW and are not required to be obtained by the Settling Defendant pursuant to this SOW. The Settling Defendant shall use reasonable efforts to obtain written procedures and requirements from GD-OTS regarding access to and work conduct within the secured portions of Area 9 where work associated with the RD/RA is to be performed, and shall attempt to comply with the GD-OTS procedures and requirements to the extent practicable.

2. Quality Assurance and Quality Control

The Settling Defendant shall develop a Site-specific Quality Assurance Project Plan ("QAPP") covering all phases of Site work to be performed by the Settling Defendant, based upon the Consent Decree and guidance provided by U.S. EPA. The QAPP shall at a minimum include:

- Project description
- Project organization
- Project responsibilities
- Sampling and sampling custody procedures
- Calibration procedures
- Quality assurance objectives
- Analytical procedures
- Data analysis and reporting
- Internal Quality Control (QC) checks
- Performance and system audits
- Preventive maintenance
- Method specific procedures for assessing data precision, accuracy and completeness
- Corrective actions
- Quality Assurance (QA) reports

In addition, the Settling Defendant shall submit drafts of a Construction Quality Assurance Plan ("CQAP") (as described in Paragraph V.C.3.) and an Operation and Maintenance QAPP ("O&M QAPP") to U.S. EPA for review with the Preliminary Design Submittal (see Task 3 description below). The Settling Defendant shall incorporate required corrections in the final CQAP and O&M QAPP, to be submitted with the 95% design package or pre-final design submittal. Document review shall be governed by Paragraph 14 of the Consent Decree.

3. Site Safety Plan

The Settling Defendant shall develop a site-specific Safety Plan which is designed to protect on-site personnel and area residents from physical, chemical, and all other hazards posed by this Remedial Action.

With respect to any work to be carried out at Area 9, the Site Safety Plan shall incorporate as much as practicable and if available to the Settling Defendant: (1) the zones of exclusion established considering, among other concerns, the quantity/distance limitations regarding munitions manufacturing applicable to GD-OTS at the time of the work; (2) the pertinent substantive safety requirements set forth in Chapter 3 and, to the extent applicable, Chapter 10 of the DOD (Department of Defense) Contractors' Safety Manual for Ammunition and Explosives (DOD 4145.26-M); and (3) coordination with GD-OTS safety personnel of any work in areas within the quantity/distance limitations.

The Safety Plan shall develop the performance levels and criteria necessary to address the following areas:

- General requirements

- Personnel
- Levels of protection
- Safe work practices and safeguards
- Medical surveillance
- Personnel and environmental air monitoring
- Personal protective equipment
- Personal hygiene
- Decontamination – personnel and equipment
- Site work zones
- Contaminant control
- Contingency and emergency planning
- Logs, reports and record keeping

The Safety Plan shall follow U.S. EPA guidance and all Occupational Safety and Health Administration ("OSHA") requirements as outlined in 29 C.F.R. 1910 (51 FR 45654). The Settling Defendant shall submit a draft Safety Plan for U.S. EPA review with the Preliminary Design Submittal. The Settling Defendant shall incorporate all required corrections in the final Safety Plan submitted with the 95% design package. Document review shall be in accordance with the Consent Decree.

4. Sampling and Analysis Plan

The Settling Defendant shall develop a Sampling and Analysis Plan ("SAP") which will include specifications for sampling and analysis of soil, groundwater, and surface water, as necessary, that will be conducted during and after the implementation of the groundwater Remedial Action (including soil excavation). As part of the SAP, the Settling Defendant shall recommend a monitoring well network to assess the compliance of the remedial activities and to assess whether new or further corrective measures need to be taken at the Site. This monitoring well network shall include groundwater sampling and analysis. The parameters for analysis of groundwater samples shall be based on the results of the pre-design groundwater sampling and analysis and on other data use objectives.

B. TASK 2 - RD/RA WORK PLAN DEVELOPMENT

Within 60 calendar days of U.S. EPA approval of the final Pre-design Report, the Settling Defendant shall submit a Remedial Design/Remedial Action Work Plan ("RD/RA Work Plan") to U.S. EPA for review and approval detailing the following activities, and describing in detail the information that will be included in the plan listed below. In addition, the RD/RA Work Plan shall be submitted to the other Parties named in the Consent Decree.

C. TASK 3 - REMEDIAL DESIGN

The Settling Defendant shall prepare final construction plans and specifications for the Remedial Design to accomplish the Remedial Action for groundwater as set forth in the ROD Amendment and in accordance with Sections III and IV, above.

1. Design Phases

Meetings shall occur between the Parties to the Consent Decree to discuss Remedial Design issues. The Settling Defendant shall develop the plans and specifications in the sequence outlined below. Document review shall be in accordance with Paragraph 14 of the Consent Decree and dispute resolutions shall be governed by Section XIV of the Consent Decree.

With respect to Area 9, all design packages submitted by the Settling Defendant shall take into account as much as practicable, to the extent relevant information is available to the Settling Defendant:

- the zones of exclusion established considering, among other concerns, the quantity / distance limitations regarding munitions manufacturing applicable to GD-OTS at the time of the work;
- the pertinent substantive safety requirements set forth in Chapter 3 and, to the extent applicable, Chapter 10 of the DOD (Department of Defense) Contractors' Safety Manual for Ammunition and Explosives (DOD 4145.26-M);
- variances in the timing and phasing of work to take advantage of periods when the quantity / distance limitations do not apply or are less stringent; and
- coordination with GD-OTS safety personnel of any work in areas within the quantity / distance limitations.

a. Preliminary Design

The Settling Defendant shall provide a Preliminary Design Submittal within 90 calendar days following U.S. EPA approval of the RD/RA Work Plan or the Pre-design Report, whichever is later. The design effort should be approximately 30% or 50% complete. This submittal shall consider the results and build upon the recommendations of the Pre-design Work. The Preliminary Design shall reflect a level of effort such that the technical requirements of the project have been addressed and outlined so that they may be reviewed to determine if the Final Design will provide an operable and usable Remedial Action. The Preliminary Design Submittal shall include: the first draft of the CQAP; the O&M QAPP; groundwater extraction system test plans; a generic O&M Plan; the Basis of Design; and construction drawings and specifications.

b. Pre-final / Final Design

Pre-final / Final Design documents shall be submitted in two parts. The first submission shall be at 95% completion of design (i.e., pre-final). The Pre-final Design Submittal shall adequately address all comments made on the Preliminary Design Submittal. After approval of the Pre-final Design Submittal, the required revisions, if any, shall be executed and the final documents shall be submitted 100% complete and specifications ready for construction contracting bid advertisement. This portion of the document package as submitted for Pre-final / Final Design shall include, but not be limited to: the CQAP; the O&M Plan; the Basis of Design; final construction drawings and specifications; and a construction schedule ("RA Schedule").

Coordination shall be consistent with the submission requirements of the drawings and specifications through Pre-final / Final Design. The Pre-final Design shall reflect a level of effort such that the technical requirements of the project have been addressed and outlined so that they may be reviewed to determine if the Final Design meets the applicable requirements for the project. Construction drawings shall reflect organization and clarity. Technical specifications shall be outlined in a manner reflecting the final specifications. Design notes, calculations, supporting data, and other documentation shall be included with the Final Design Submittal.

The technical specifications governing the groundwater extraction and treatment system shall include contractor requirements for providing: appropriate service visits by experienced personnel to supervise the installation, adjustment, startup, and operation of the system; and appropriate operational procedures training once the startup has been successfully accomplished.

All design packages submitted by the Settling Defendant shall be in accordance with CERCLA procedures on compliance with other environmental laws. Refer to "CERCLA Compliance with Other Environmental Statutes," Appendix to Preamble of the National Oil and Hazardous Substances Pollution Contingency Plan, Final Rule, (50 FR 2892.6) November 20, 1985, for additional information. All ARARs identified in the ROD Amendment and in the Focused Feasibility Study ("FFS") - Revision 3 shall be analyzed and incorporated into the design.

In accordance with CERCLA Section 121(e), no permits shall be required for work carried out entirely on-site. For any work which requires a permit, the following shall be identified and the pertinent requirements thereof incorporated into the Preliminary, Pre-final, and Final Design Submittals:

- the permitting authority(ies);
- construction/operating permits required;
- time required by the permitting agency(ies) to process the application(s);

- monitoring and/or compliance testing requirements; and
- promulgated regulations governing applications, exemptions, variances, etc.

For work on-site, which otherwise would require a permit, the substantive requirements identified as ARARs shall be identified in and incorporated into the in the Preliminary, Pre-final and Final Design Submittals.

The Settling Defendant shall obtain, complete, and provide all required application forms to the appropriate permitting authority. Copies of all correspondence from permitting agencies which either describe permit requirements, or indicate that no permits are necessary, shall be furnished to U.S. EPA.

2. Excavation Plan

As a component of the Remedial Design documents, the Settling Defendant shall include an Excavation Work Plan which describes in detail the work necessary to implement the excavation and off site disposal of soil within the 1 mg/kg CVOC contour in accordance with the Remedial Action as set forth in the ROD Amendment and in accordance with Sections III and IV, above. A schedule for performance of the excavation work ("Excavation Schedule") shall be submitted along with the Excavation Work Plan.

3. Construction Quality Assurance Plan

The Settling Defendant shall develop a construction quality assurance program including, but not limited to, the following topics: responsibility and authority; personnel qualifications; inspection activities; sampling requirements; data management and interpretation; corrective measures; and documentation. The initial draft Construction Quality Assurance Plan ("CQAP") shall be submitted with the Pre-final Design Submittal.

4. Operation and Maintenance Plan

The Settling Defendant shall develop and submit to U.S. EPA for approval an Operation and Maintenance Plan to ensure the safe and effective implementation of this remedy. The basic elements of the O&M Plan shall include:

a. Normal Operation and Maintenance

- Describe tasks for operation.
- Describe tasks for maintenance.
- Describe optimum groundwater extraction and treatment conditions
- Present schedule.

b. Potential Operating Problems

- Describe potential sources of problems or failure.
- Present common remedies or alternatives.
- Describe information sources for suggested actions to correct operating problems.

c. Routine Monitoring and Testing

- Present description of monitoring tasks detailed in the SAP.
- Present required laboratory testing detailed in the SAP.
- Present required QA/QC to ensure proper system operation.
- Maintain daily operating logs and maintenance records.

d. Preventative System Maintenance and Testing

- Present tasks necessary to identify required system repairs.
- Describe monitoring and testing results necessary for groundwater extraction and treatment system optimization, repair or other work to maintain the design, performance criteria for the system.
- Describe equipment replacement contingencies.
- Maintain daily operation logs, periodic inspection logs and maintenance records.
- Describe responses to problems identified at inspections.
- Retain all laboratory data and testing results.
- Describe procedures for reporting emergencies.
- Schedule reports to agencies.

The Settling Defendant shall develop an initial draft O&M Plan during the Remedial Design phase. To ensure correlation with all design activities, the initial draft O&M Plan shall be submitted with the Preliminary Design Submittal. The Settling Defendant shall submit the final O&M Plan with the Pre-final (95%) Design Submittal for U.S. EPA review and approval.

D. TASK 4 - REMEDIAL ACTION IMPLEMENTATION

1. Preconstruction Inspection and Meeting

After the Remedial Action contractor(s) has been secured and before implementation of on-site construction activities, a pre-construction meeting and inspection should be held at the Site. The purpose of this inspection and meeting is to identify and resolve potential problems with implementation of the approved design documents. This meeting and inspection will involve at a minimum, U.S. EPA, the Settling Defendant's project coordinator and Remedial Action contractor(s), and DOI.

2. Soils Excavation

The Settling Defendant shall excavate soils in accordance with the approved Excavation Plan and Schedule.

3. Remedy Construction

The Settling Defendant shall construct the Remedial Action in accordance with the approved Remedial Design documents, plans, and schedules.

4. Pre-Final Inspection

When the Settling Defendant believes that it has completed the startup of the groundwater extraction and treatment system for Plume 1, and the other construction elements of the approved Final Design for Plume 1 and 3, and prior to its submission of the Notification of Completion of Construction and final report in accordance with Paragraph 86 of the Consent Decree, a pre-final inspection shall be held at the site. This inspection will involve, at a minimum, U.S. EPA and the Settling Defendant's project coordinator and remedial action contractor(s).

5. Final Inspection

If any deficiencies in the Remedial Action implementation are identified in the pre-final inspection, the Settling Defendant shall correct the deficiencies and then submit a Notification of Completion of Construction and final report to U.S. EPA in accordance with Paragraph 86 of the Consent Decree. Upon receipt of the Notification of Completion of Construction and final report, a final inspection will be held and will involve, at a minimum, U.S. EPA and the Settling Defendant's project coordinator and remedial action contractor(s). If the final inspection, Notification of Completion of Construction, and final report demonstrate that physical construction and installation of the remedial actions selected for Plumes 1 and 3 have been completed, and the remedial action for Plume 1 is operating properly and successfully, a Certificate of Completion of Construction will be issued by U.S. EPA in accordance with Paragraph 86 of the Consent Decree.

6. Operation and Maintenance

Following issuance of a Certification of Completion of Construction, U.S. DOI shall perform all operation, maintenance, and monitoring for groundwater Plumes 1 and 3 as may be required under the Consent Decree (including Appendix 5), the SOW, the ROD, the O&M Plan(s), or any other plans implemented pursuant to this Consent Decree.

E. TASK 5 - SCHEDULE AND REPORTING

1. Monthly Progress Reports

The Settling Defendant shall, at a minimum, provide the U.S. EPA, DOI, and the Illinois Environment Protection Agency ("IEPA") with signed monthly progress reports during the design phase. These reports shall contain:

- A description and estimate of the percentage of the RD/RA completed;
- Summaries of all unforeseen field conditions, sampling and test results, and all other data or pertinent information received during the month that has not been previously submitted;
- Summaries of all changes made in the RD/RA during the reporting period;
- Summaries of all significant contacts with representatives of the local community, public interest groups, or State government during the reporting period;
- Summaries of all problems or potential problems encountered during the reporting period;
- Actions being taken to rectify problems;
- Changes in key personnel during the reporting period;
- Projected work for the next reporting period; and
- Copies of daily reports, inspection reports, and laboratory and monitoring data that have not been previously submitted.

2. Schedules

The Settling Defendant shall develop schedules demonstrating the time for conduct of the Pre-design Work; development of the Remedial Design; soils excavation; and construction and initial start-up of the Remedial Action. The Pre-design Schedule shall be submitted to U.S. EPA for review and approval with the Pre-design Work Plan. The RD Schedule shall be submitted to U.S. EPA for review and approval with the RD/RA Work Plan. The Excavation Schedule shall be submitted to U.S. EPA for review and approval with the Excavation Work Plan. The RA Schedule shall be submitted to U.S. EPA for review and approval with the Pre-final (95%) Design. Review and approval of the schedules will be in accordance with Paragraph 14 of the Consent Decree.

The schedules shall include time frames, duration, and specific dates (month, day, and year), where appropriate, for submittal of all documents for U.S. EPA review and approval, initiation and completion of specific tasks, and meetings to discuss submittals as provided for in the Consent Decree and this SOW. The schedules, to the extent practicable, shall provide for the timing and phasing of work to take advantage of periods when the munitions manufacturing quantity / distance limitations applicable to GD-OTS do not apply or are less stringent. The

schedules shall also, to the extent practicable, take into account the need to coordinate work with GD-OTS safety personnel in areas within the quantity / distance limitations. The schedules shall also include planned sampling and monitoring activities. The Settling Defendant shall account for potential multiple submittals of a deliverable and other contingencies and plan the schedules accordingly.

Key milestones for the Excavation Schedule and Pre-design Schedule are:

- Submit Pre-design Work Plan – within 60 calendar days after entry of the SOW.
- Submit Results of Pre-design Work – on or before the deadline in the approved Pre-design Schedule.

Key milestones for the RD Schedule are:

- Submit RD/RA Work Plan – no later than 60 calendar days after U.S. EPA approval of the final Pre-design Report. All revisions shall be submitted in accordance with Paragraph 14.c. of the Consent Decree, except revisions of the RD/RA Work Plan or other submittals specified in the SOW, if required, shall be submitted within 30 calendar days after U.S. EPA's comments on the previous submittal of the document have been addressed by the Settling Defendant to the satisfaction of U.S. EPA.
- Submit Excavation Work Plan – in conjunction with the RD/RA Work Plan (no later than 60 calendar days after U.S. EPA approval of the final Pre-design Report).
- Submit Preliminary (30% to 50%) Design Submittal concurrently with the RD/RA Work Plan or concurrently with the Pre-design Report, whichever is later.
- Submit the Pre-final (95%) Design Submittal – within 90 calendar days after receipt of approval or final comments on the Preliminary Design Submittal.
- Submit the Final Design Submittal – within 30 calendar days after receipt of final comments on the Pre-final Design Submittal. If the Pre-final Design Submittal is approved without comment, it shall function as the Final Design.

Key milestones for the RA Schedule are:

- Secure Remedial Action Contractor – within 90 calendar days after approval of the Final Design Submittal.
- Begin implementation of Remedial Action – within 30 calendar days after award of the Remedial Action contract.

3. Operation and Maintenance Oversight Reports

At a minimum, the Settling Defendant before issuance of the Certification of Completion of Construction, and DOI after issuance of the Certification, shall provide the U.S. EPA and IEPA with signed semi-annual Progress Reports for Operation and Maintenance Activities. These reports shall contain:

- Summaries of all inspections;
- Summaries of all unforeseen field conditions, sampling and test results, and all other data or pertinent information received during the reporting period;
- Summaries of all problems or potential problems encountered during the reporting period;
- Actions taken or being taken to rectify problems;
- Summaries of all significant contacts with representatives of the local community, public interest groups, or State government during the reporting period;
- Changes in key personnel during the reporting period;
- Projected work for the next reporting period; and,
- Copies of inspection reports and laboratory and monitoring data.

In addition to the above, Quarterly Groundwater Extraction and Treatment Reports shall be provided. These reports shall include groundwater monitoring well, treatment, and extraction system performance data, as well as an assessment of the performance of the system.

ATTACHMENT C

APPENDIX 5

SUPPLEMENTAL AGREEMENT BETWEEN THE U.S. DEPARTMENT OF THE INTERIOR AND SCHLUMBERGER TECHNOLOGY CORPORATION REGARDING THE PCBs OPERABLE UNIT, CRAB ORCHARD NATIONAL WILDLIFE REFUGE

I. PURPOSE

This Supplemental Agreement is made and entered into by the U.S. Department of the Interior, including the U.S. Fish and Wildlife Service (collectively "U.S. DOI"), and Schlumberger Technology Corporation ("STC") for the purpose of resolving matters not addressed within the body of the consent decree in United States v. Schlumberger Industries, Inc. (S.D. Ill.) ("Consent Decree"), which relates to the PCBs Operable Unit at the Crab Orchard National Wildlife Refuge ("Refuge"). This Supplemental Agreement was first executed by U.S. DOI and Schlumberger Industries, Inc. in 1991 when the Consent Decree was executed and is being updated and amended by U.S. DOI and STC to reflect current and anticipated future circumstances at the PCBs Operable Unit. This Supplemental Agreement, as amended, resolves the respective claims of U.S. DOI and STC, with regard to the PCBs Operable Unit, arising pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act. This Supplemental Agreement is appended to and incorporated into the Consent Decree, and it shall be read together with the provisions of that Decree. Execution of the Consent Decree signifies consent to the terms of this Supplemental Agreement by STC and U.S. DOI. All terms of this Supplemental Agreement have the meaning set forth in the Consent Decree except as otherwise specified here. This Supplemental Agreement is effective upon entry of the Consent Decree, except that Section III (Reimbursement) shall be effective as of the date of lodging of the Consent Decree (subject to suspension of Work due to lack of entry of the Decree). Nothing in this Supplemental Agreement is or shall be construed as an admission of fact or liability for any purpose by any party. Nothing in this Supplemental Agreement shall be construed as limiting or otherwise affecting STC's obligations under the Consent Decree to satisfy the Performance and Cleanup Standards set forth in the ROD and ROD Amendment.

II. OBLIGATIONS FOR WORK

A. Soils, Sediments, and Surface Water

1. STC will perform the Work as provided in the Consent Decree related to soils, sediments, and surface water, except for Operation and Maintenance of the remedial action for soils, sediments, and surface water following issuance of a Certification of Completion of Soil, Sediment, and Surface Water Work by the U.S. Environmental Protection Agency ("U.S. EPA"). After issuance of a Certification of Completion of Soil, Sediment, and Surface Water Work by U.S. EPA, STC will perform any additional Work which

may be required by U.S. EPA in accordance with the Consent Decree, except for Operation and Maintenance. U.S. DOI will not be liable under this Supplemental Agreement for any stipulated penalties assessed by U.S. EPA against STC for violations of STC obligations under the Consent Decree.

2. Except as provided in Section IV of this Appendix 5, U.S. DOI will perform and finance all Operation and Maintenance activities related to soils, sediments, and surface water regarding the PCBs Operable Unit following issuance of a Certification of Completion of Soil, Sediment, and Surface Water Work by U.S. EPA. For purposes of this Section II (A) and Section IV, Operation and Maintenance means maintaining the East and West Swale sediment retention basins and maintaining the PCBs repository by preserving the repository cap from erosion or other conditions that could result in migration of PCBs. STC will not be liable under this Supplemental Agreement for any stipulated penalties U.S. EPA may seek to assess against U.S. DOI for violations of U.S. DOI obligations under the Consent Decree or the Interagency Agreement between the U.S. DOI, U.S. EPA, and the Department of Defense regarding the Refuge.

B. Groundwater

1. STC will perform the Work as provided in the Consent Decree, the Record of Decision (ROD), and any amendments to the ROD which are incorporated into the Consent Decree for groundwater Plume 1, Plume 2, and Plume 3 in accordance with Section V of this Appendix 5. After issuance of a Certification of Completion of Construction by U.S. EPA in accordance with Paragraph 86 of the Consent Decree, as amended, STC will perform any additional Work which may be required by U.S. EPA in accordance with the Consent Decree, except for maintenance, operation, and monitoring activities regarding remedial actions selected for groundwater Plume 1, Plume 2, or Plume 3 as provided in Section V of this Appendix 5. U.S. DOI will not be liable under this Supplemental Agreement for any stipulated penalties assessed by U.S. EPA against STC for violations of STC obligations under the Consent Decree.

2. Except as provided in Section V of this Appendix 5, U.S. DOI shall perform and finance the maintenance, operation, and monitoring activities regarding remedial actions for groundwater Plume 1, Plume 2, and Plume 3, commencing after U.S. EPA issues a Certification of Completion of Construction. U.S. DOI will copy STC on all reports, sampling or monitoring data, or other information provided to U.S. EPA relating to the groundwater remedies, and, at a minimum, U.S. DOI shall provide STC with an annual report that

includes all sampling and monitoring data relating to the groundwater remedies collected during the year to enable STC to assess the effectiveness of the remedial actions and track progress toward attaining Cleanup Standards. U.S. DOI shall provide written notification to STC within 30 days after U.S. DOI reasonably believes that Cleanup Standards have been met for a particular Plume.

3. U.S. DOI will perform and finance all long term maintenance, operation, and monitoring activities for groundwater relating to the PCBs Operable Unit commencing immediately after U.S. EPA issues the Certification of Completion of Remedial Action in accordance with Paragraph 87 of the Consent Decree.

4. For purposes of this Section II (B) and Section V, "maintenance, operation, and monitoring activities" means all activities, including active treatment and monitored natural attenuation, required to maintain, operate, and monitor the remedial actions implemented by STC at the PCBs OU pursuant to the Consent Decree, the ROD, the ROD Amendment, and any amendments incorporated into the Consent Decree for groundwater Plume 1, Plume 2, or Plume 3 to achieve Performance and Cleanup Standards, all activities required to remove all facilities, wells, and other infrastructure associated with these remedial actions, and all activities to restore areas impacted by these remedial actions to habitat consistent with the Refuge Comprehensive Conservation Plan for those areas.

5. STC will not be liable under this Supplemental Agreement for any stipulated penalties U.S. EPA may seek to assess against U.S. DOI for violations of U.S. DOI obligations under the Consent Decree or the Interagency Agreement between U.S. DOI, U.S. EPA, and the Department of Defense regarding the Refuge.

III. REIMBURSEMENT

1. For purposes of this Section III and Sections VI(A)-(C) & (F), reimbursable costs are those out-of-pocket costs incurred by STC to implement the activities required by Sections VI(A)-(C) & (F) or to implement the requirements of the Consent Decree, including but not limited to the costs of treatability testing, other pre-design work, remedial design, remedial action, and the capital costs of any additional Work required of STC pursuant to the Consent Decree, the ROD, and any amendments to the ROD which are incorporated into the Consent Decree. Reimbursable costs also include any oversight costs assessed by the State of Illinois. Reimbursable costs do not include STC payroll or STC overhead costs, dispute resolution costs, stipulated penalties assessed by U.S. EPA against STC for violations of STC obligations under the Consent Decree, or U.S. EPA or U.S. DOJ oversight costs.

2. a. Within ten (10) days after lodging of the amended Consent Decree, U.S. DOI and STC shall each designate and notify the other of its Authorized Representative for Administration, who shall oversee the financial aspects of implementing the reimbursement provisions of this Supplemental Agreement.

b. STC shall submit semi-annual written requests for reimbursement to the U.S. DOI Authorized Representative for Administration.

c. U.S. DOI shall reimburse STC for 50% of reimbursable costs within sixty (60) days of receipt of a reimbursement request. Subject to Section IX of this Supplemental Agreement, nothing in this Supplemental Agreement is intended or shall be construed to affect the rights of U.S. DOI and STC to seek recovery from any person not a party to the Consent Decree of any costs expended and not reimbursed pursuant to this Supplemental Agreement.

d. STC shall maintain accounting records of all reimbursable costs in accordance with generally accepted accounting principles and shall make such records, including any supporting cost documentation, to the extent it exists, available on request for review by U.S. DOI or its duly authorized representatives.

e. If U.S. DOI believes that STC has made an accounting error or that a cost item is included that represents costs which are inconsistent with or not incurred in implementing the Consent Decree or this Supplemental Agreement, U.S. DOI may withhold payment of the disputed amount and initiate dispute resolution in accordance with Section XIV of the Consent Decree on or before the date its reimbursement is due.

IV. OPERATION AND MAINTENANCE FUNDS

A. Soils, Sediments, and Surface Water

1. Following issuance by U.S. EPA of the Certification of Completion of Soil, Sediment, and Surface Water Work, STC shall reimburse U.S. DOI 50% of the first $15,000 of Operation and Maintenance costs incurred by U.S. DOI each year for the first 20 years following issuance of the Certification of Completion of Soil, Sediment, and Surface Water Work, for Operation and Maintenance. Calculation of annual expenses shall begin on the date of issuance of the Certification of Completion of Soil, Sediment, and Surface Water Work, and end on the day immediately preceding the anniversary of the issuance date. At the conclusion of the twentieth year, U.S. DOI shall be responsible for 100% of the Operation and Maintenance costs.

2. a. Within 30 days following the end of the annual calculation period, U.S. DOI shall submit a written request to STC for reimbursement. STC shall reimburse U.S. DOI for the STC

percentage of reimbursable costs within sixty (60) days of receipt of a reimbursement request.

b. U.S. DOI shall maintain accounting records of all reimbursable costs and shall make such records, including any supporting cost documentation, to the extent it exists, available on request for review by STC or its duly authorized representatives.

c. If STC believes U.S. DOI has made an accounting error or that a cost item is not reimbursable under this Section IV A., STC may withhold payment of the disputed amount and initiate dispute resolution in accordance with Section XIV of the Consent Decree.

V. GROUNDWATER OPERATIONAL RESPONSIBILITIES AND FUNDING

A. Groundwater

1. Upon issuance of a Certification of Completion of Construction by U.S. EPA pursuant to Paragraph 86 of the Consent Decree, or four months following STC's submittal of the Notification of Completion of Construction and final report to EPA, which ever occurs later, STC and U.S. DOI personnel shall jointly maintain, operate, and monitor the remedial actions implemented by STC pursuant to the Consent Decree for groundwater Plume 1, Plume 2, or Plume 3 to achieve Performance and Cleanup Standards for four months, during which period STC and U.S. DOI shall continue to share costs equally.

2. At the conclusion of the four month joint operating period, U.S. DOI shall maintain, operate, and monitor the remedial actions for groundwater constructed pursuant to the Consent Decree and STC shall reimburse U.S. DOI 50% of its costs for maintenance, operation, and monitoring activities. STC's reimbursement obligation under this Section V A. shall last until U.S. EPA issues the Certification of Completion of Remedial Action pursuant to Paragraph 87 of the Consent Decree, and all activities required to remove all facilities, wells, and other infrastructure associated with these remedial actions, and all activities to restore areas impacted by these remedial actions to habitat consistent with the Refuge Comprehensive Conservation Plan for those areas have been completed.

3. For purposes of this Section V, "costs for maintenance, operation, and monitoring activities" are those out of pocket costs incurred by U.S. DOI for maintenance, operation, reporting, or monitoring activities associated with the remedial actions for groundwater implemented by STC at the PCBs OU. Except as specifically provided in Paragraph 4 of this Section V.A., costs for

maintenance, operation, and monitoring activities do not include U.S. DOI payroll or overhead costs, dispute resolution costs, stipulated penalties U.S. EPA may seek to assess against U.S. DOI for violations of U.S. DOI obligations under the Consent Decree or the Interagency Agreement between U.S. DOI, U.S. EPA, and the Department of Defense regarding the Refuge, or U.S. EPA, U.S. DOJ, or State of Illinois oversight costs.

4. At the conclusion of the four month joint operating period discussed in Paragraph 2 of this Section V.A., STC agrees to reimburse U.S. DOI up to $15,000 per year for U.S. DOI overhead and payroll costs associated with the maintenance, operation, or monitoring of the remedial actions for groundwater installed by STC at the PCBs OU. For purposes of this Paragraph, reimbursable overhead and payroll costs are those costs associated with the following tasks performed by the U.S. DOI-authorized personnel: (1) contract negotiation, management, and contractor oversight associated with the maintenance, operation, or monitoring of the remedial actions for groundwater; (2) sample collection, analysis, or reporting; or (3) maintenance, operation, reporting, or monitoring tasks specified in the Final Design Report(s) for the selected remedies and not otherwise performed by contractors. U.S. DOI shall maintain accounting records of all reimbursable overhead and payroll costs and shall make such records, including any supporting cost documentation, to the extent it exists, available on request for review by STC or its duly authorized representatives. STC's obligation under this Paragraph shall be renegotiated by STC and U.S. DOI either: (1) upon shutdown of the Plume 1 treatment system; or (2) eleven years following the conclusion of the four month joint operating period, whichever occurs first.

5. a. U.S. DOI shall submit written requests for reimbursement to STC semi-annually. STC shall reimburse U.S. DOI for the STC percentage of costs for maintenance, operation, and monitoring activities within sixty (60) days of receipt of a reimbursement request.

b. U.S. DOI shall maintain accounting records of all costs for maintenance, operation, and monitoring activities and shall make such records, including any supporting cost documentation, to the extent it exists, available on request for review by STC or its duly authorized representatives.

c. If STC believes U.S. DOI has made an accounting error or that a cost item is not reimbursable under this Section V A., STC may withhold payment of the disputed amount

and initiate dispute resolution in accordance with Section XIV of the Consent Decree.

VI. ADDITIONAL WORK AND COMPENSATION

A. Industrial Area Human Health Risk Assessment and Incremental Sampling Program

1. STC will conduct an Industrial Area Human Health Risk Assessment and Incremental Sampling Program (IA HHRA) in accordance with a U.S. DOI approved work plan.

2. U.S. DOI shall reimburse STC 50% of its reimbursable costs incurred in implementing the IA HHRA in accordance with the definitions and procedures set forth in Section III of this Appendix 5.

B. Center Swale

1. STC and U.S. DOI acknowledge that the Center Swale contains useful habitat. STC will address U.S. DOI drainage concerns relating to the center swale pond area, consistent with Work Plan (1), which by this reference is incorporated herein and attached to this Appendix 5 as Exhibit 1. STC and U.S. DOI do not expect the cost of construction to exceed $40,000.00. In the event such costs exceed $40,000.00, STC will remain responsible for the satisfactory implementation of Work Plan (1).

2. U.S. DOI shall reimburse STC 50% of its reimbursable costs incurred in constructing the Center Swale drainage solutions consistent with Work Plan (1), in accordance with the definitions and procedures set forth in Section III of this Appendix 5.

C. East and West Swales

1. STC and U.S. DOI agree that the construction of sediment retention basins in the East and West Swales, as described in the Work Plan attached hereto as Exhibit 5, is important to protect the integrity of the remedial measures taken in the Crab Orchard Lake and was undertaken for the purpose of meeting remedial action goals prescribed by the ROD and Consent Decree. U.S. DOI agrees to reimburse STC 50% of the reimbursable costs incurred in constructing the sediment retention basins in the East and West Swales at the Site.

D. Removal of Building and Acquisition of Property

1. In order to address U.S. DOI concerns regarding lost or injured habitat at the Site, STC will remove Building S-4-3 and scarify the ground in the area previously occupied by Building S-4-3 and adjacent parking lot, consistent with Work Plan (2), which by this reference is incorporated herein and attached to this Appendix 5 as Exhibit 2. In addition, STC will provide to U.S. DOI $40,000.00 for the acquisition and preservation of habitat within or immediately adjacent to the Refuge.

E. Fish Tissue Study

1. STC will provide $20,000 for a fish study to be conducted on Crab Orchard Lake by the State of Illinois, consistent with Work Plan (3), which by this reference is incorporated herein and attached to this Appendix 5 as Exhibit 3. STC's obligation to pay $20,000 for the fish study referenced in the preceding sentence is expressly conditioned on the State of Illinois' or U.S. DOI's payment of $20,000 in matching funds for the fish study and compliance with Work Plan (3). If the State of Illinois or U.S. DOI fail to provide $20,000 in matching funds to be used in conducting the fish study, or perform the study in a manner consistent with Work Plan (3), all of STC's obligations under this Section VI.E. will be automatically rescinded.

F. Sampling at Depth Near Building I-1-3 and Site 28

1. STC will conduct sampling activities near Building I-1-3 and Site 28 consistent with Work Plan (4), which by this reference is incorporated herein and attached to this Appendix 5 as Exhibit 4. STC and U.S. DOI agree that sampling concentrations indicating exceedances of ROD Cleanup Standards or a risk to human health will be reported to EPA for its consideration of further remedial action under the ROD and Consent Decree.

2. U.S. DOI shall reimburse STC 50% of its reimbursable costs incurred in conducting sampling activities consistent with Work Plan (4), in accordance with the definitions and procedures set forth in Section III of this Appendix 5.

VII. REPRESENTATIONS TO U.S. EPA

Upon STC's completion of all activities described in the work plan to be submitted pursuant to Section VI. A. and the Work Plans attached to this Appendix 5 as Exhibits 1, 2, and 4, and U.S. DOI's approval of such activities, U.S. DOI will be satisfied that the concerns raised in the U.S. Fish and Wildlife Service Report dated July 2006 have been addressed and resolved, and hereby agrees to represent to U.S. EPA in writing that: (1) the concerns raised in the U.S. Fish and Wildlife Report dated July 2006

have been addressed and resolved; and (2) U.S. DOI has no objection to U.S. EPA's issuance of a Certification of Completion of Soil, Sediment, and Surface Water Work to STC pursuant to Paragraph 85(b) of the Consent Decree.

VIII. COVENANTS NOT TO SUE

U.S. DOI and STC each hereby covenant not to sue or take administrative action against the other as provided in the Consent Decree; provided, however, that such covenants do not include any claims based on a failure by U.S. DOI or STC to meet the requirements of the Consent Decree or this Supplemental Agreement, which shall first be enforced through the dispute resolution provisions of the Consent Decree. Also excluded from these covenants, and from the assignment of claims in Section IX below, are claims (to the extent they are available under law) arising from a claim or action relating to the PCBs Operable Unit, or any portion thereof, brought by any person not a signatory to the Consent Decree against U.S. DOI or STC under federal or state law. Also excluded from these covenants is STC's right to bring an action against U.S. DOI for recovery of response costs in the event that, due to lack of funding, U.S. DOI is not able to meet the requirements of this Consent Decree. DOI and STC agree not to assert against each other an apportionment of costs and responsibilities that differs from the apportionment set forth in the Consent Decree and in this Supplement of Agreement.

IX. ASSIGNMENT OF CLAIMS

Except as otherwise specifically provided in the Consent Decree (including this Appendix) STC hereby assigns to U.S. DOI all of its claims under CERCLA against all potentially responsible parties ("PRPs") with respect to the PCBs Operable Unit, except for its claims against Olin Corporation and any related entity. STC and U.S. DOI each fully retain all rights and claims that each may have with respect to Olin Corporation and any related entity. STC agrees to provide U.S. DOI with all pertinent non-privileged information in its possession regarding the potential liability of other PRPs at the PCBs Operable Unit. STC further agrees that, except with respect to Olin Corporation or any related entity, the United States will completely retain any monetary recovery it obtains from other PRPs.

X. TERMINATION OF PRIOR AGREEMENT

The Cooperative Agreement between the Department of the Interior U.S. Fish and Wildlife Service and Sangamo Weston, Inc. executed on March 3, 1986, regarding performance of a remedial investigation and feasibility study for the Refuge, is hereby terminated.

XI. RESERVATION OF RIGHTS

Unless otherwise specifically stated in this Supplemental Agreement, U.S. DOI and STC each retains all rights, claims, obligations, liabilities, and responsibilities that it would have in the absence of this Supplemental Agreement. Nothing in this

Supplemental Agreement nor any performance hereunder shall create any rights on behalf of any third party.

EXHIBIT 1

Work Plan 1 (Version 1)
Storm Water Center Swale
Best Management Practice Retrofit
Crab Orchard National Wildlife Refuge (CONWR)
March 4, 2011

Overview

The particular work outlined in this work plan is focused on both upstream and downstream of the center swale area that crosses the access road near the repository. In general, the work involves raising the elevation of the road crossing and the installation of structural best management practices (BMPs) to minimize the possibility of flooding across the road and near the repository and/or carrying silts and sediments to Crab Orchard Lake. The main components of this work involve:

- Installation of erosion and sedimentation control measures;
- Supply fill material and contour existing roadway to proposed grade elevations;
- Installation of structural storm water BMPs including:
    - rock filter dams
    - inlet sediment trap (Silt Saver); and
    - storm drain outlet

The intent of this action is to provide for the construction and implementation of a retrofit system of the existing center swale storm water basin. This is not to be construed as a design of an additional retention/detention/sedimentation pond/basin and thus construction of such facilities is not expected. Rather, the design included herein is for the enhancement of an existing swale to assist in velocity reduction during a storm runoff event with the benefit of natural sedimentation/filtration of fine particles or sediment during high volume storm flows.

Scope of Work

The description of work herein is provided as a general guide. **Sheet 1** of the attached plans outlines the general area of work proposed in this Work Plan.

Install Erosion and Sedimentation Control Devices

Prior to commencement of the intrusive work, approximately 600 linear feet of Type "C" silt fence will be installed around the upstream and downstream swale. All fill material brought to the area and stockpiled (if necessary) must also be protected from erosion using silt fencing.

Erosion control will be required due to the location of the swale, the presence of standing water upstream of the roadway, and the proximity to Crab Orchard Lake. To ensure that no sediment leaves the site, erosion and sediment control measures will be required. Specifically, the structural BMPs necessary for this project will involve the placement of silt fencing around each excavation area. Two rows of Type-C (Sd1-C) silt fence will be placed along the surrounding areas where fill material will be placed protective of the upgradient and downgradient swales. Mechanized equipment, tooling, and soil stockpiles will be staged within the erosion-controlled and protected areas. **Sheet 2** illustrates the approximate areas of erosion control fencing while **Sheet 4** provides the detail and specifications of the construction and installation of the fence.

Installation of Structural Best Management Practices

Three structural BMPs will be installed during the re-grading effort. Three rock filter dams will be installed upstream of the roadway across the swale to limit runoff velocity and filter high volume flows during rain events. Additionally, a sediment filter trap will be installed in the southwest portion of the swale upstream of the roadway to filter out sediment from travelling through culverts beneath the roadway yet not impeding the flow. Finally, a storm drain outlet will be installed on the downstream swale northeast of the road to handle flows without damaging the swale and roadway from erosion or sedimentation.

Rock Filter Dam

Three rock filter dams will be constructed upstream of the access roadway in the center swale. The purpose of the dams is to serve as a sediment filter device in the drainage way to trap incoming sediment loads and reduce velocity under high flow conditions. The exact locations of the dams are indicated on **Sheets 1, 2, and 3**. The spacing between the dams will be verified based upon field surveys of the finished elevation of the top of the rock in the upstream dam. Construction specifications for the dams are as follows.

Each filter dam will be constructed on top of a geotextile separating the stone from the soil base material to prevent particles from the subgrade migrating into the graded stone. The geotextile shall meet AASHTO M288-96 (Section 7.5) specifications for permanent erosion control. The geotextile should be placed immediately adjacent to the subgrade without any voids and extend at least five feet downstream of the toe of the dam to prevent scour.

The dam will be constructed by hand to ensure the dam extends completely across the channel and is securely tied into both channel banks. The dam center of the downstream dam must be at least 6-inches below the elevation of the upstream dam. Boulders should be used in the dam and be of 3-5 lb. in size with the smaller stone on the upstream side for filtering. The dam center should be at least 6-inches lower than the outer edges of the dam along the channel banks. The side slopes shall be 2:1 or flatter. The dam width (along the top) shall be no less than 6-feet. **Sheet 4** provides further detail on the construction specifications for this BMP.

Sediment Filter Trap

A sediment filter trap will be installed on the upstream side of the access road immediately next to the roadway. **Sheet 3** illustrates the location of the sediment BMP. A SS-100A Round Frame Silt Saver storm water filter and safety guard is specified for use as the sediment filter trap at the center swale's location just south of the access road. The SS-100A will be coupled with a SS-500 Bottom Drain Attachment to rout storm water beneath the roadway to the northern portion of the swale.

The 60-inch diameter Silt Saver and bottom drain will be constructed in the southern portion of the swale by excavating sufficient soils to emplace the 12-inch diameter drain system with minimum cover to allow adequate slope beneath the road to the northern portion of the swale. In order to perform this work, any existing water (if present in the southern portion of the swale area) will be temporarily contained using a makeshift berm out of the spoils collected in the swale. Once the construction area is free of liquids and safe for excavation, the Bottom Drain Attachment will be installed.

Initially, the existing dual 12-inch diameter corrugated metal pipe (CMP) culvert system will be removed to make way for the new piping system. New pipe bedding will be excavated in the same general trench as the old culvert. The pipe bedding will consist of a gravel bedding consisting of #57 stone. The Bottom Drain Attachment system will incorporate a 12-inch diameter corrugated HDPE pipe laid across the roadway within the stone bedding trench. The piping will extend to the northern section of the swale at a minimum slope of 1% and be constructed to meet the conditions of the Storm Drain Outlet (see below). **Sheet 4** and **Sheet 5** provide the details for the construction of this BMP while **Sheet 6** provides the specification for the filter assembly itself.

The Silt Saver sediment trap will be situated on top of the Bottom Drain Attachment and secured using the hardware provided. The sediment trap assembly will also include an overflow pipe constructed of the same 12-inch diameter corrugated pipe oriented in a vertical position of the southern section of the swale and teed into the main underflow drain line. The overflow pipe is included to allow for an emergency drain should the Silt Saver become clogged and limit the flow through it or under very high storm water flows where runoff collection overwhelms the sediment trap. The length of the vertical overflow pipe will be set at an elevation approximately 4-inches below the final elevation of the roadway. The specification for the Bottom Drain Attachment is shown on **Sheet 7**.

The Silt Saver trap will be covered with the Silt Saver Filter made of a non-woven needle punched, heat set polyester for continuous filtration of fines through the device. The 60-inch diameter filters are manufactured by Silt Saver, Inc. and can be obtained with the purchase of the Silt Saver SS-100A sediment trap.

Storm Drain Outlet

The piping exit of the Bottom Drain Attachment will extend beyond the access roadway bed a minimum of 5-feet. The outfall is needed to slow the runoff velocity, retain potential sediment, stabilize the grade, and reduce erosion. Construction details for this BMP are presented below.

The HDPE corrugated pipe will exit the outfall and be encased in rip rap. The piping and surrounding stone will be constructed on top of a geotextile separating the stone from the soil

base material to prevent particles from the subgrade migrating into the graded stone. The geotextile shall meet AASHTO M288-96 (Section 7.5) specifications for permanent erosion control. The geotextile should be placed immediately adjacent to the subgrade without any voids and extend at least six feet downstream of the invert of the pipe to prevent scour. The location of the Storm Drain Outlet is presented on **Sheet 3**.

Rip rap stone will consist of 6-inch diameter stone to be placed by hand ensuring the stone extends at least 3-feet across the bottom of channel at a 12-inch depth and extend at least 1-foot up the channel banks. Details and specifications of the Storm Drain Outlet are presented on **Sheet 5**.

Raise Elevation of Access Road between Swales

The area of concern shall be surveyed to a relative datum to determine the particular grade elevations specified on the plan. Approximately 7,000 square feet of existing roadway will be reshaped and contoured to raise the elevation of the access road. During construction of the road, the existing storm water culverts will be removed and replaced with the specified piping to allow the continued flow from topographic upstream to down stream swale Final elevations will raise the road approximately two-feet in the area.

The existing elevation of the access road between the northern and southern sections of the center swale is too low and subject to potential washout and overtopping. Additionally, the sediment filters structural BMPs discussed above require an elevated berm downstream to function properly. To accomplish this, the access road between the swale sections must be raised.

In order to change the roadway elevation and raise it to the required grade, approximately 520 cubic yards of fill material will be needed. The roadway will be raised 1-foot from existing grade at the northwest and southeast portions of the road between the repository and southern section of the swale. The access road between the two sections of swale (north and south) will require approximately a rise of 2-feet in elevation. The Contractor will provide the required volume of fill material to accomplish this in a safe manner by preventing the material from entering the storm swale system. The new fill must be graded to meet existing elevations along the exterior boundaries of the filled area. **Sheet 1** illustrates the area of roadway that must be raised to meet

this specification. Existing and proposed contour intervals are shown to direct the work effort. The general location of the grading work is contained on **Sheet 3**.

Materials

The existing roadway will be filled with clean soil in 12-inch compacted lifts (15-inch loose) to 98% of standard Proctor density. All select soil material shall be from a source approved by the Engineer and shall be free of roots, organics and boulders (> 1" diameter) which could adversely affect compaction. The Contractor will be required to perform analytical sampling/testing of the backfill source to confirm the clean fill is free of contamination. Placement and compaction of the backfill should be adequate to ensure support of the surface traffic by heavy machinery. Backfill material should be granular, free flowing and non-corrosive inert material. Sand or crushed rock are suitable materials. Unit costs for backfill material shall be included.

Fill shall be placed in horizontal layers in thicknesses compatible to the material being placed, equipment used, and the compaction requirements. Each layer shall be evenly spread and moistened or aerated as required to achieve the required water content (as determined using soil field density testing by the Nuclear Method ASTM D2922-96). Each lift will be compacted by a combination of tamping, pneumatic-tire or smooth drum steel-wheeled roller, or sheep's foot roller, or other mechanical means to produce the specified compaction and desired surface condition of each lift layer. Where it is inappropriate to use self-propelled equipment, hand directed compaction equipment will be used. Final compaction densities may be subject to final inspection and testing by a geotechnical technician confirming that required density is met. The following material specifications shall be followed when appropriate for use of designated material as specified:

- Washed coarse sand having the following gradation by weight percent passing:

Percent Passing	Sieve
100%	3/8 inch
95-100	#4
80-100	#8
50-85	#16
25-60	#30
10-30	#50
2-10	#100

- Crushed gravel/stone (crush and run) shall be aggregate size 57 having the following gradation by weight:

Percent Passing	Sieve
100%	1½ inch
95-100	1 inch
25-60	½ inch
0-10	#4
0-5	#8

- Select fill or other granular material approved by the Engineer free from organic matter having the following gradation by weight:

Percent Passing	Sieve
100%	1 inch
95-100	½ inch
30-65	¼ inch
0-10	#200 (ASTM D 422)

All moisture/density testing, if required by the Engineer, shall be conducted in the field in accordance with Water Content of Soils in Place by Nuclear Method ASTM Standard D3017-96. Compaction shall be 98% standard Proctor.

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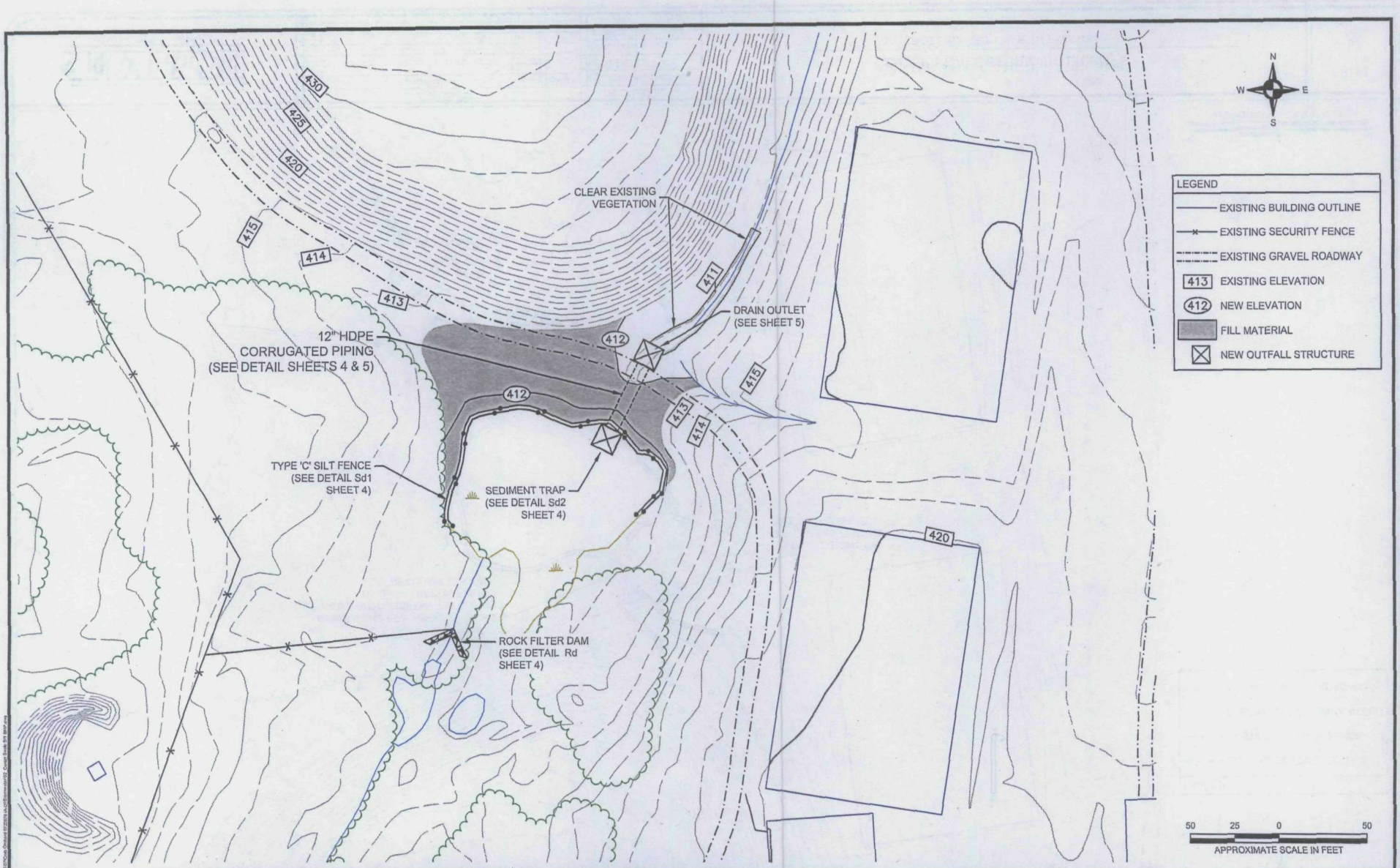
PROJECT #:	07-20876C
DESIGNED:	KAC
APPROVED:	
DRAFTER:	APR/PRM
DATE:	08/06/10

EXISTING CENTER SWALE STORMWATER BMPS

CRAB ORCHARD • MARION • ILLINOIS

SHEET 1



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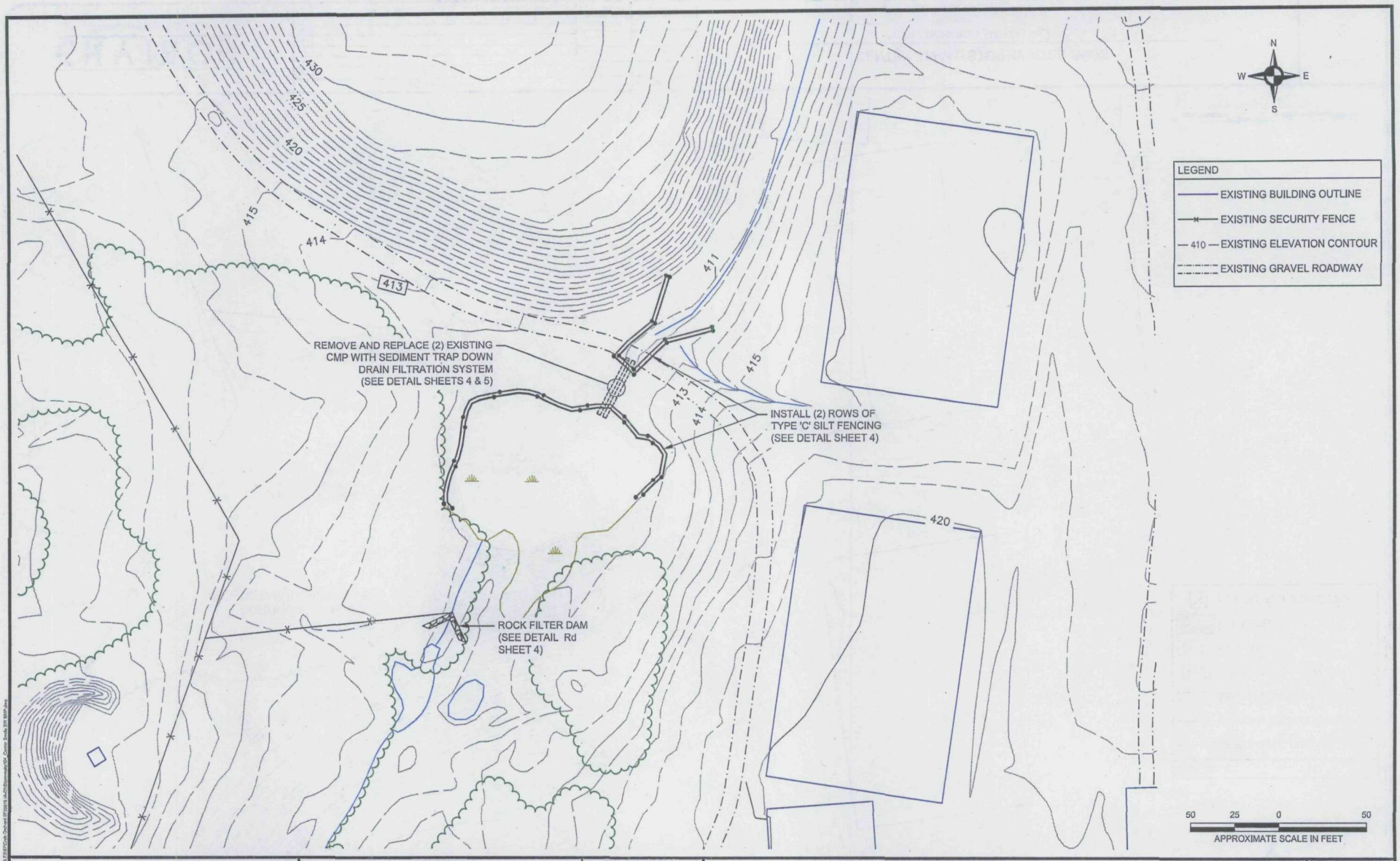
PROJECT #:	07-20876C
DESIGNED:	KAC
APPROVED:	
DRAFTER:	APR
DATE:	03/26/10

CENTER SWALE STORMWATER BMPS

CRAB ORCHARD • MARION • ILLINOIS

SHEET 2



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CENTER SWALE STORMWATER BMPS

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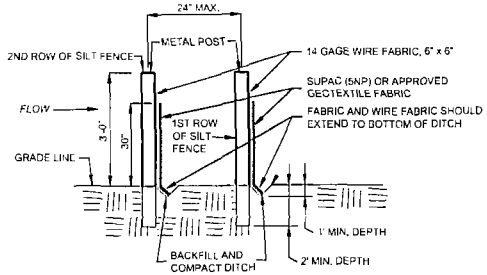
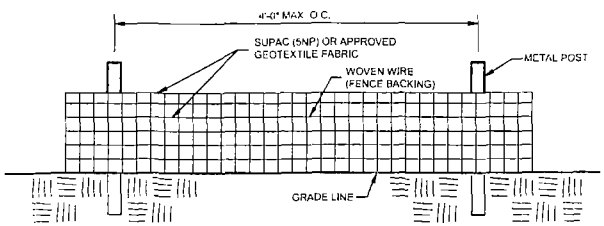
SHEET 3



SILT FENCE SHALL BE CHECKED AFTER EVERY RAIN EVENT, AND ACCUMULATED SILT SHALL BE REMOVED.

SIDE VIEW DETAIL OF TYPE 'C' SILT FENCE (Sd1)

(NTS)

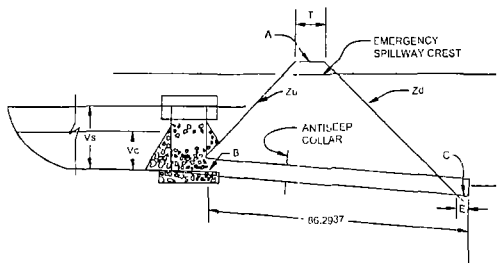


GROUND SLOPE	LENGTH OF SILT FENCE PER 1/4 ACRE OF DRAINAGE AREA
< 2.0 %	100'
2.0 TO 5.0 %	75'
5.0 TO 10.0 %	50'
10 % TO 20 %	25'
> 20.0 %	15'

NOTES
1. INSTALL SILT FENCE BEFORE CONSTRUCTION HAS BEGUN
2. SILT FENCE WILL BE INSTALLED IN TWO(2) ROWS.

FRONT VIEW DETAIL OF TYPE 'C' SILT FENCE (Sd1)

(NTS)

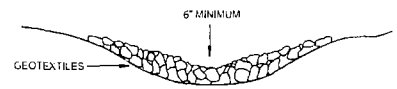


PRINCIPAL SPILLWAY DESIGN

T = TOP WIDTH OF DAM, FT.
ZU = UPSTREAM SIDE SLOPE
ZD = DOWNSTREAM SIDE SLOPE

A = TOP OF DAM ELEVATION
B = LOWEST ELEVATION OF PIPE AT RISER
C = LOWEST ELEVATION OF PIPE AT OUTLET
E = EXTENDED LENGTH OF PIPE BEYOND TOE OF DAM
L = TOTAL LENGTH OF PIPE, FT.

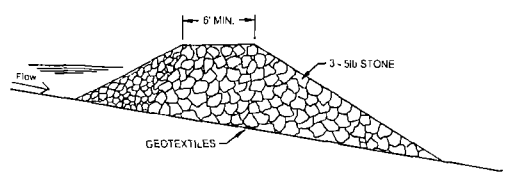
$L = [A - (B + C)/2] [ZU + ZD] + T + E$



NOTE SEDIMENT TRAP IS TO BE CLEANED OUT WHEN VOLUME BECOMES HALF FULL.

SEDIMENT TRAP (Sd2)

(NTS)



NOTE ROCK SIZE DETERMINED ACCORDING TO SPECIFICATIONS SET FORTH IN APPENDIX C.

ROCK FILTER DAM (Rd)

(NTS)

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APPROVED	
DRAFTER:	APR
DATE:	09/26/10

CENTER SWALE STORMWATER BMP DETAILS

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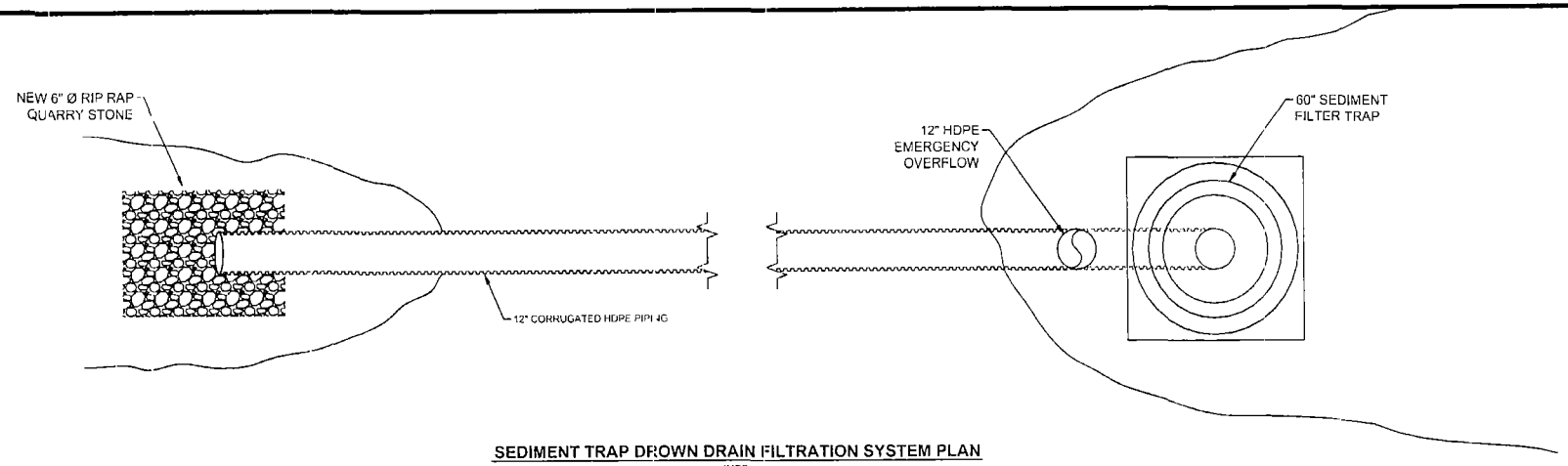
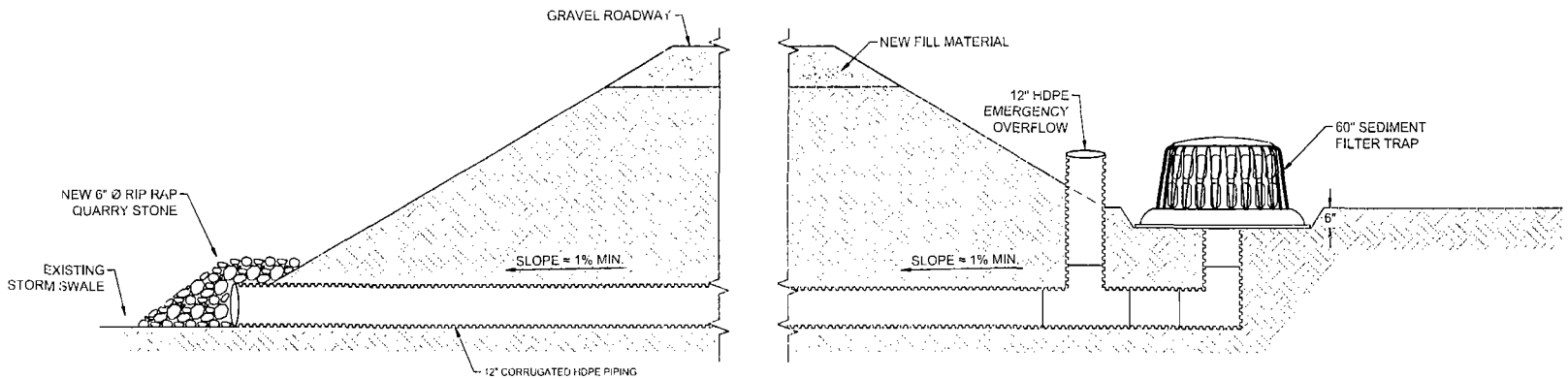
SHEET 4



SEDIMENT TRAP DROWN DRAIN FILTRATION SYSTEM PLAN
(NTS)



SEDIMENT TRAP DROWN DRAIN FILTRATION SYSTEM PROFILE
(NTS)

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DRAFTER:	APR
DATE:	03/26/10

SEDIMENT TRAP DOWN DRAIN FILTRATION SYSTEM
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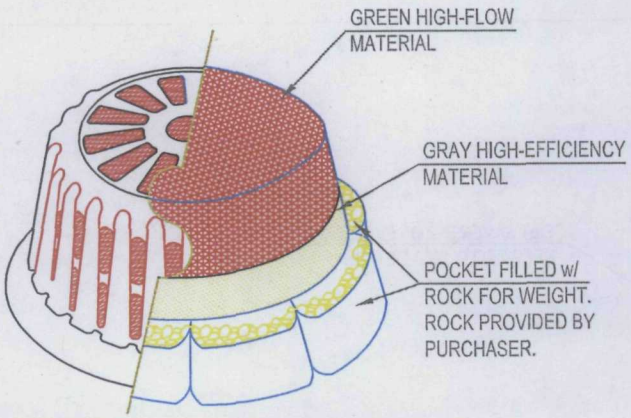
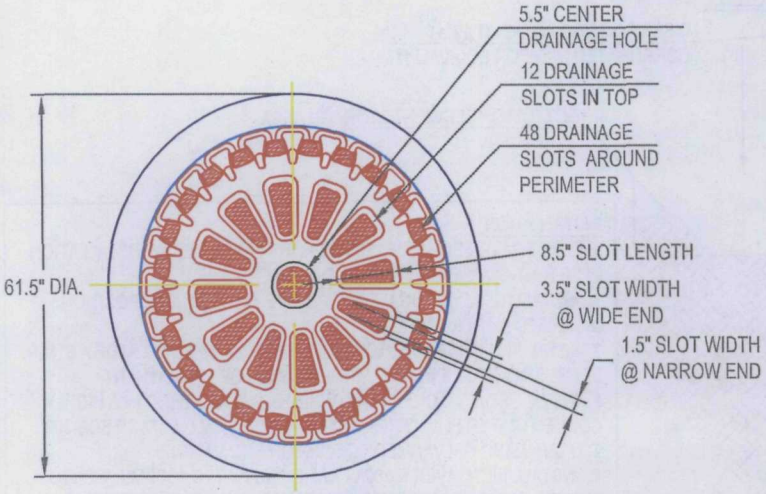
SHEET
5

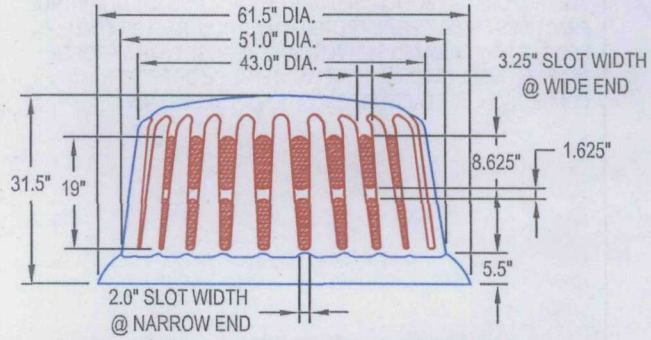


ISOMETRIC VIEW

SHOWN WITH ROADWAY PROJECTS FILTER HAT



PLAN VIEW



ELEVATION VIEW

REPLACEMENT FILTERS: MODEL # R-140

FILTER OPTIONS

FILTER HAT IS AVAILABLE IN THREE OPTIONS:

1) ALL HIGH-FLOW MATERIAL
2) ALL HIGH-EFFICIENCY MATERIAL
3) HIGH-FLOW MATERIAL ON TOP HALF OF HAT, HIGH-EFFICIENCY MATERIAL ON BOTTOM HALF (THIS FILTER COVER IS RECOMMENDED FOR ALL ROADWAY PROJECTS.)

IT IS THE PURCHASERS RESPONSIBILITY TO PURCHASE APPROPRIATE FILTER HAT. PURCHASER SHALL PROVIDE ROCK FOR FILTER POCKETS.

FILTER HAT INSTALLATION

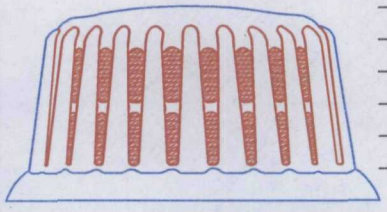
FILTER HAT SLIDES DIRECTLY OVER FILTER FRAME. TO KEEP FILTER FRAME IN PLACE OVER STORM STRUCTURE, ROCK POCKETS ARE SEWN DIRECTLY INTO FILTER HAT MATERIAL. EVERY FILTER HAT COMES IN ONE PIECE FOR EASY INSTALLATION.

MAINTENANCE

ALL TEMPORARY EROSION, SEDIMENTATION, & POLLUTION CONTROL PRACTICES SHOULD BE INSPECTED DAILY. CONTRACTOR SHALL REMOVE SEDIMENT AND DISPOSE OF IN A PROPER MANNER. INSPECT R-100A DAILY FOR CUTS, ABRASIONS, AND PROPER INSTALLATION. REPLACE OR REPOSITION AS NECESSARY.

SPECIFICATIONS

FILTER FABRIC SILT-SAVER HAT SHALL BE BASED ON DESIGN PROFESSIONAL'S SPECIFICATIONS.



FRAME & FILTER DISCHARGE ANALYSIS

HEAD (FT)	EQUATION USED	OPENING AREA (SF)	FRAME FLOW (CFS)	FILTER AREA (SF)	FILTERED FLOW (CFS)
0.5	O	2.1	7	6	2
1.0	O	3.9	19	12	3
1.5	O	7.0	41	18	5
2.0	O	8.0	54	24	7
2.5	O	9.2	70	30	9
3.0	O	9.2	77	—	77

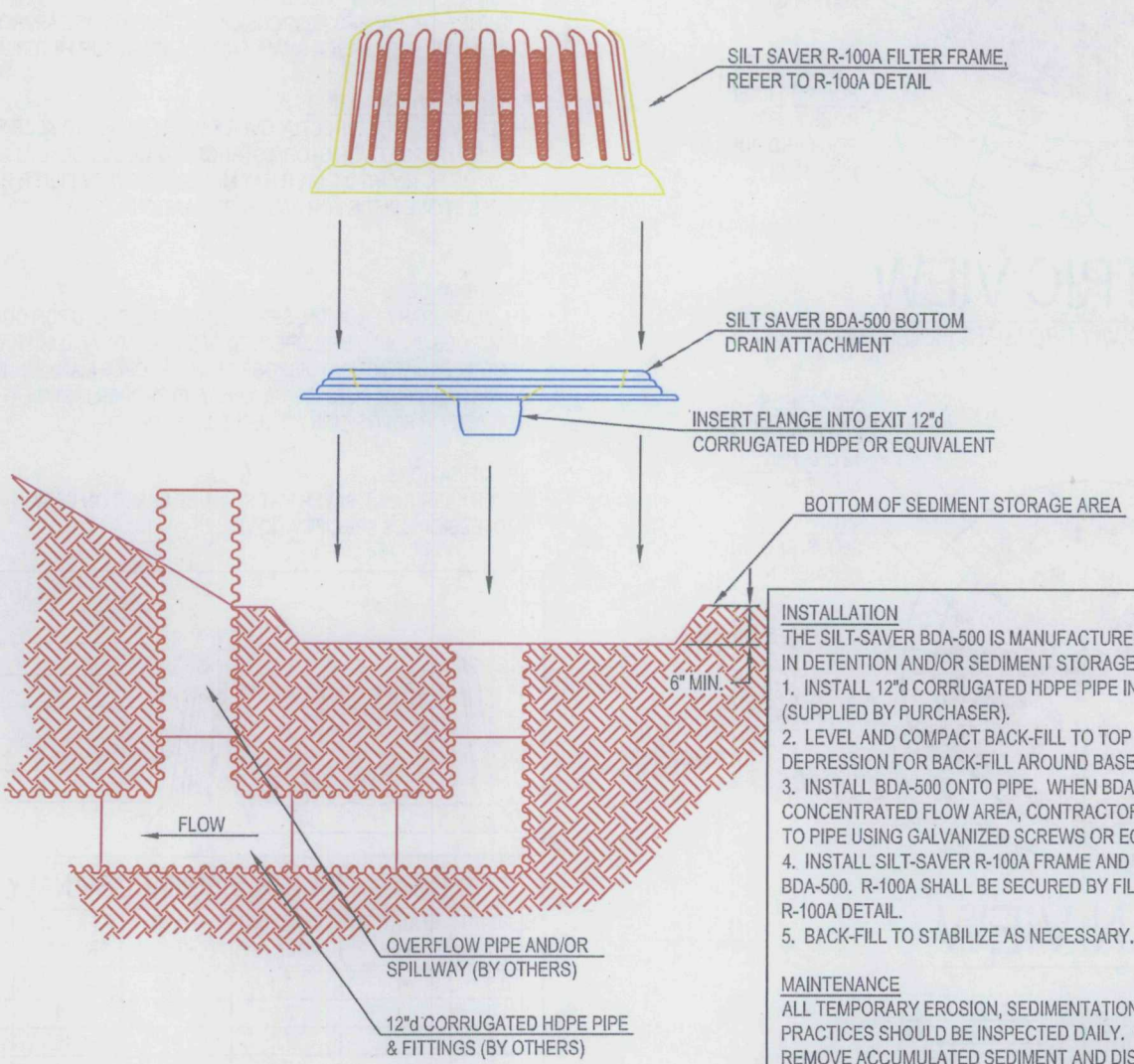
DUE TO NARROW SLOT, A TRANSITION WILL OCCUR BETWEEN WEIR AND ORIFICE CONDITIONS. ORIFICE FLOW WILL PROVIDE A MORE CONSERVATIVE ESTIMATE OF FLOW, THEREFORE THE LESSER OF THE ORIFICE AND WEIR FLOWS WILL BE USED FOR EACH STAGE CALCULATION.

FILTER MATERIAL ALLOWS 129 gpm/SF OR 0.29cfs/SF
ORIFICE EQUATION (O) = $Q=0.6A(2gh)^{0.5}$
P = FEET PERIMETER
h = HEAD IN FEET
Q = CAPACITY IN cfs
A = FREE OPEN AREA OF FRAME
g = 32.2 FEET-PER-SECOND/SECOND

SILT-SAVER
Sediment Control Products

ROUND FRAME & FILTER ASSEMBLY
Model # R-100A

FRAME MATERIAL: BLACK 0.25" HMWPE
FILTER FABRIC MATERIAL: REFER TO SPEC
SCALE: NOT TO SCALE
LAST UPDATED: APRIL 2010



INSTALLATION

THE SILT-SAVER BDA-500 IS MANUFACTURED FOR EASY INSTALLATION IN DETENTION AND/OR SEDIMENT STORAGE AREAS:

1. INSTALL 12"d CORRUGATED HDPE PIPE IN A VERTICAL POSITION (SUPPLIED BY PURCHASER).
2. LEVEL AND COMPACT BACK-FILL TO TOP OF PIPE. PROVIDE A 6" MIN. DEPRESSION FOR BACK-FILL AROUND BASE OF ATTACHMENT.
3. INSTALL BDA-500 ONTO PIPE. WHEN BDA-500 IS USED IN A HIGHLY CONCENTRATED FLOW AREA, CONTRACTOR SHALL ATTACH BDA-500 TO PIPE USING GALVANIZED SCREWS OR EQUIVALENT.
4. INSTALL SILT-SAVER R-100A FRAME AND FILTER ASSEMBLY ONTO BDA-500. R-100A SHALL BE SECURED BY FILLING FILTER POCKETS PER R-100A DETAIL.
5. BACK-FILL TO STABILIZE AS NECESSARY.

MAINTENANCE

ALL TEMPORARY EROSION, SEDIMENTATION, & POLLUTION CONTROL PRACTICES SHOULD BE INSPECTED DAILY. CONTRACTOR SHALL REMOVE ACCUMULATED SEDIMENT AND DISPOSE OF IN A PROPER MANNER. INSPECT BDA-500 FOR MAINTENANCE OF PROPER CONNECTION. REPLACE OR REPOSITION AS NECESSARY.

SILT-SAVER
Sediment Control Products

BOTTOM DRAIN ATTACHMENT
Model # BDA-500

FRAME MATERIAL: BLACK 0.25" HMWPE

SCALE: NOT TO SCALE

LAST UPDATED: APRIL 2010

SILT-SAVER, INC. 1094 CULPEPPER DRIVE, CONYERS, GA 30094 PHONE: (770) 388-7818 FAX: (770) 388-7640 TOLL FREE: 1-888-382-SILT (7458) www.siltsaver.com

EXHIBIT 2

Work Plan 2 (Version 1)
Demolition of Building S-4-3
Crab Orchard National Wildlife Refuge (CONWR)
March 4, 2011

Overview

This Work Plan was developed for the demolition of Building S-4-3 located on the east side of Highway 148 in the Crab Orchard National Wildlife Refuge (CONWR) in Marion, Illinois. Building S-4-3 is located within Legal Land Description: Section 20, T9S, R2E, 3rd PM. As required in the Industrial Policy of 1981, Building S-4-3 was identified for demolition following the Lessee vacating the building. Following demolition of Building S-4-3, the approximately 5.7-acre property will be tilled so that the United States Fish and Wildlife Service (USFWS) can replant the area.

The subject building is a single story wood frame and steel clad structure reportedly built in 1947 that covers approximately 19,833 square feet. The building was previously leased by Southern Illinois University (SIU) and was used for excess property storage until vacated in 1997. During the exit process, asbestos containing material (ACM) was determined to exist in pipe wrapping, wall covering (i.e., Transite siding), and possibly roofing materials. The ACM pipe wrapping was reportedly removed. However, asbestos containing siding and/or roofing materials still remain on the structure.

Transite is an asbestos reinforced cement board used for siding, roofing and wallboard. The material is classified as Category II non-friable ACM ("Category II material") because it cannot be crushed or pulverized by hand pressure. However, Category II materials may become regulated ACM (RACM) due to the high probability of becoming crumbled or pulverized (i.e., friable) during the demolition process. Therefore, the siding must be removed prior to razing the structure in order to maintain its non-regulated classification.

Scope of Work – Building Demolition

Prior to mobilizing for the demolition activities, engineering plans, as-built drawings, site plans, and any other available site-specific information will be reviewed to verify construction blueprints and materials and to identify the location of utilities. Information obtained in the document review task and a comprehensive site-specific Health and Safety Plan (HASP) and Construction Quality Assurance (CQA) Plan will be included with contractor solicitation materials. Because

the structure contains Category II material, properly trained and licensed personnel will be required for the demolition work.

The selected contractor will be responsible for preparing the building for demolition including submitting appropriate demolition notifications, acquiring necessary permits, improving site access as necessary to complete the work, installing erosion control structures, and if present, removing universal wastes (i.e., mercury switches, lighting ballasts, florescent bulbs, etc.) and other de minimus potentially hazardous materials (i.e., paint, solvent, fuel, chemicals, etc).

Siding and roofing material will be removed by hand methods before the building is razed. Mechanical hand tools that do not grind, sand, saw, or abrade will be used to remove individual Transite panels from the building structure. The individual panels will be lowered to the ground and stacked (i.e., not dropped or thrown) in manageable sized stacks. The stacks of Transite panels will be wetted prior to loading in trucks or roll-off containers in the event that some panels are broken in the loading process. The properly removed Category II materials will be disposed off-site as construction debris at a properly licensed disposal facility.

Following removal of Category II material, the remaining structure will be demolished. The means, methods and equipment to be used in the demolition process will be identified by the demolition contractor. Any salvageable equipment and/or recyclable scrap will be segregated by the contractor. The remaining demolition debris will be loaded and transported to a licensed construction debris landfill.

The contractor will break and remove the concrete building slab following demolition of the structure. Demolished concrete will be recycled by the contractor to the extent practicable. Upon removal of the concrete, backfill will be placed and compacted to fill the void left by the removed foundation.

Preparation for Reforestation

As a precondition to planting, a check will be made to confirm that apparent surface construction debris (e.g. concrete, rebar, steel, wood) has been removed from the site and the soil will be scarified to a depth of approximately 12 to 18 inches and finished with an offset disc or disc harrow to break up any compacted soil.

Assumptions

- The removal of Transite panels can be performed using hand methods that are not destructive in nature (i.e., sanding, sawing, grinding, or abrade).

- The previous asbestos survey can be relied upon for this demolition work and a new asbestos survey and/or Hazard Assessment will not be necessary.
- All Regulated ACM with the exception of Transite materials have been removed from the structure and analysis of siding and roofing materials has been performed to document the presence of ACM.
- No RCRA hazardous or characteristically hazardous waste is present.
- Post demolition verification and/or environmental sampling is not required.
- Air sampling and/or personnel monitoring is not required.
- The USFWS will implement, oversee, and take responsibility for the planting and maintenance efforts once the site is tilled.

EXHIBIT 3

Work Plan 3 (Version 1)
Fish Tissue Collection Guidelines
Crab Orchard National Wildlife Refuge (CONWR)
March 4, 2011

Overview

The purpose of this work plan is to provide guidelines for fish tissue collection and analysis that are specific for Crab Orchard Lake (COL) and are consistent with the Illinois Environmental Protection Agency's (IEPA's) Fish Contaminant Management Program (FCMP) Standard Operating Procedures ([SOP] dated 2002, as described in IEPA 2006). These guidelines address procedures and data quality objectives associated with:

- Target fish species
- Sample type, size of fish, and number of fish per location
- Sample collection locations and field documentation
- Sample Designation
- Fish sample preparation and handling
- Decontamination procedures
- Laboratory analysis and QA/QC Considerations

Scope of Work

Target Fish Species

Three species have been repeatedly collected from COL since 1985 as part of ongoing monitoring activities, and these species are the focus of 2010 fish consumption advisories (FCAs). The species reflect three distinct levels within the fisheries food web, in accordance with the FCMP, and will therefore be the primary focus of future sampling efforts:

- Predatory species: largemouth bass (LMB)
- Omnivorous species: channel catfish (CC)
- Bottom feeder species: carp

Sample Type and Size of Fish and Number of Fish

Sample types must be composite fillet samples. Each individual composite sample must be comprised of between three and five fish from a single species of roughly similar size and weight. According to the IEPA FCMP SOP, a composite of 5 fish is preferred.

Individual LMB and CC must be 2 pounds or larger, and carp must be 3 pounds or larger. For all three species, within any individual composite sample, the smallest fish in the composite sample must be at least 75% of the length of the largest fish in the sample.

Two composite fillet samples per species will be collected at each sample location, as this is consistent with the number of samples per species that has been routinely monitored. Therefore, 6 to 10 individual fish will be required to comprise the 2 composite fillet samples of each species of fish.

Identification of Sample Collection Locations

Four sample locations should be sampled. Fish sampling can occur over several acres in the general vicinity of these locations. The specific locations will mimic previously sampled locations.

- RNA-1: location near the dam
- RNA-2: location east of Route 148 (E-148)
- RNA-3: location west of Route 148 (W-148)
- RNA-4: location east of Route E-148

Sample Collection and Field Documentation

The physical collection of fish will incorporate the use of electroshocking, gill nets, or other fishing equipment as typically used by the Illinois Department of Natural Resources. Field documentation will include:

- Station code
- Date
- Collector's name
- Sample location as defined above.
- Lake Name
- Sampling techniques
- Weather conditions
- Fish species
- Individual weights and length of fish in sample
- Sample type (fillet)
- Comments about unusual conditions, if any

Sample Designation

Samples should have unique alphanumeric sample descriptor identifying the sample matrix, sampling location, sample number, and sample date.

- **Sample Matrix Code** - "Fillet", so that it may be differentiated from whole body samples at some point in the future.
- **Sampling Location** – using one of the four codes defined above.

- **Sample Date** - The date of sample collection will be included in the format of YY/MM/DD.
- **QA/QC Sample Identification** - The sample designation for QA/QC samples is similar to that of primary sampling points. The QA/QC sample matrix codes include the following:
  - "-DUP" for duplicate samples. Duplicates will be conducted by the laboratory after homogenization.
  - "-MS/MSD" for matrix spike/matrix spike duplicates.

Fish Sample Preparation and Handling

Fish preparation must include the removal of scales and fillet of the fish to remove bones (retention or removal of skin is addressed below). The total weight of the composite samples (comprised of 3 to 5 fish) must range from 1 to 5 pounds. If a fillet is too large, subsections of the fillet from the anterior, middle, and posterior sections should be used in place of the entire fillet.

The skin should be left on or removed, but should be consistent with what was previously done for historic COL sampling. According to the IEPA SOP, the skin should remain on the flesh for LMB and carp but skin should be removed for CC. It is assumed that the IEPA SOP was historically followed. However, this should be confirmed in advance of the fish collection effort so that sample preparation is replicated to ensure data comparability. The use of skin-on and skin-off designations for LMB and CC is consistent with how anglers typically prepare these fish for consumption. However, anglers rarely, if ever, consume carp with skin-on, and therefore, use of skin-on analysis is overly conservative as PCBs can partition to lipids below the skin that people do not eat. Carp are not identified as target species in the Great Lakes Guidance and as such, USEPA Great Lakes sample and collection protocols for fish do not discuss whether carp is to be analyzed with skin-on or skin-off. Other states, such as Michigan, analyze carp with skin-off. Confirmation from IEPA about how carp from COL were prepared and analyzed will be obtained prior to sampling, so this method can be followed if deemed appropriate.

In accordance with the IEPA SOP, the sample will be kept as clean as possible to avoid contamination. Each composite fillet sample will be securely wrapped in aluminum foil (shiny side out) and labeled with a pre-printed, adhesive label. In order for the laboratories to identify each composite sample with the correct station, one label will be placed on the outside of each fish sample, and the other placed on the accompanying Field/Lab form in the area designated.

All composite samples collected from a sampling station will be placed in an air tight plastic bag; to prevent contamination of samples and loss of identification numbers on pre-printed labels. The Field/Lab forms will not be placed inside the plastic bags with the fish samples. The samples will be stored on ice, or dry ice during field sampling, and frozen as soon as possible upon completion of field sampling. Samples will be shipped to the appropriate laboratory under standard Chain-of-Custody (COC) procedures.

Decontamination Procedures

Non-dedicated equipment used for sampling will be cleaned using an alcohol-based wipe prior to its initial use and again before use at each subsequent sampling area.

Laboratory Analysis and QA/QC Considerations

Sampling analysis will be done with the same lab, detection limits, QA/QC considerations, data validation and protocols as was done previously. Samples will be homogenized and analyzed for total PCBs by USEPA SW-846 Method 8082 using the laboratory's SOPs. Detection limits are to be set at approximately 0.1 mg/kg to replicate those used in past fish sampling for COL. Results should be reported on a wet-weight basis. Lipids should be analyzed and reported as percent lipids.

References

IEPA. 2006. Water Quality Monitoring Strategy. Appendix 10. Fish Sampling Protocols. http://www.epa.state.il.us/water/water-quality/monitoring-strategy/2002-2006/monitoring-strategy-2002-2006.pdf

EXHIBIT 4

Work Plan 4 (Version 1)
FWS Requested at Depth Sampling
Crab Orchard National Wildlife Refuge (CONWR)
March 4, 2011

Overview

This Work Plan was developed to address the remaining concerns expressed by the U.S. Fish and Wildlife Service (FWS) regarding PCB impacts at depth within the PCB Operable Unit (PCB OU) of the Crab Orchard National Wildlife Refuge (CONWR) in Marion, Illinois. As directed by Schlumberger, ENVIRON International Corporation (ENVIRON) prepared this work plan to collect additional soil samples for polychlorinated biphenyl (PCB) analysis from the remaining two areas where FWS had a concern, as follows:

1. Near Building I-1-3
2. Site 28

To further characterize the PCB concentrations in the subsurface soil at these locations, soil borings are proposed. Each soil boring will be advanced using direct-push techniques in accordance with Standard Operating Procedure (SOP) F-4 from the Sampling and Analysis Plan (SAP) that was attached to the USEPA-approved Final (100%) Design Report for Groundwater Plumes 1 and 3, Crab Orchard National Wildlife Refuge, PCB Areas Operable Unit, Marion, Illinois (ENVIRON, June 2010).

Schlumberger is proposing to collect the at-depth samples as requested by the FWS at these locations. The sampling at each of these areas is discussed in turn below.

Near Building I-1-3

Two at-depth sample locations have been requested by the FWS near Building I-1-3 (Figure 1). Each of these two sample locations will consist of two soil borings to a depth of 6 feet below ground surface (bgs) with discrete samples collected from the bottom six inches of each 2-foot soil interval, as follows:

- 1.5'-2.0' depth
- 3.5'-4.0' depth
- 5.5'-6.0' depth

The two soil boring locations near Building I-1-3 provided by the FWS, 48-1 and 48-3, are shown in Figure 1. As such, a total of six samples will be collected from the two soil borings at this location.

Site 28

Five soil boring locations have been requested by the FWS at Site 28. Four of these five soil boring locations (30-5 through 30-8) will consist of borings installed to a depth of 8 feet bgs with discrete samples collected from the bottom six inches of each 2-foot soil interval, as follows:

- 1.5'-2.0' depth
- 3.5'-4.0' depth
- 5.5'-6.0' depth
- 7.5'-8.0' depth

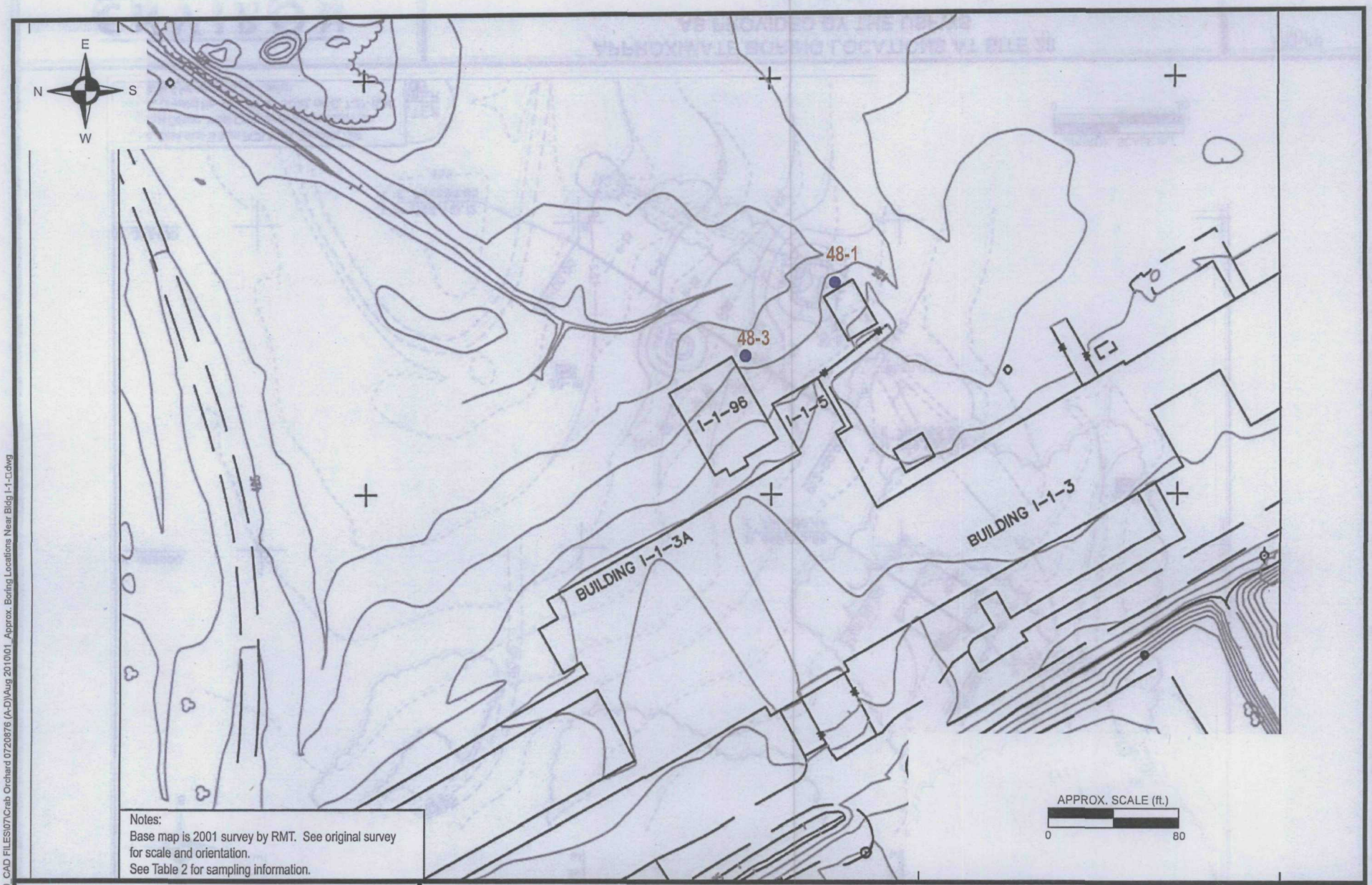
The fifth soil boring location, 30-9, will be sampled to a depth of six feet. The soil boring locations for Site 28 are illustrated in Figure 2. As such, a total of 19 samples will be collected from the five soil borings collected from Site 28.

Evaluation of Analytical Results

The results of the above sampling will be compared to the USEPA-approved at-depth site soil criterion of 25 mg/kg total PCBs. If the criterion are exceeded at these locations, a plan will be developed to delineate the PCB concentrations at the affected location and to remediate these soils, as appropriate.

Figure 1: Proposed FWS sampling locations near Building I-1-3.

Figure 2: Proposed FWS sampling locations at Site 28.



Notes:
Base map is 2001 survey by RMT. See original survey for scale and orientation.
See Table 2 for sampling information.

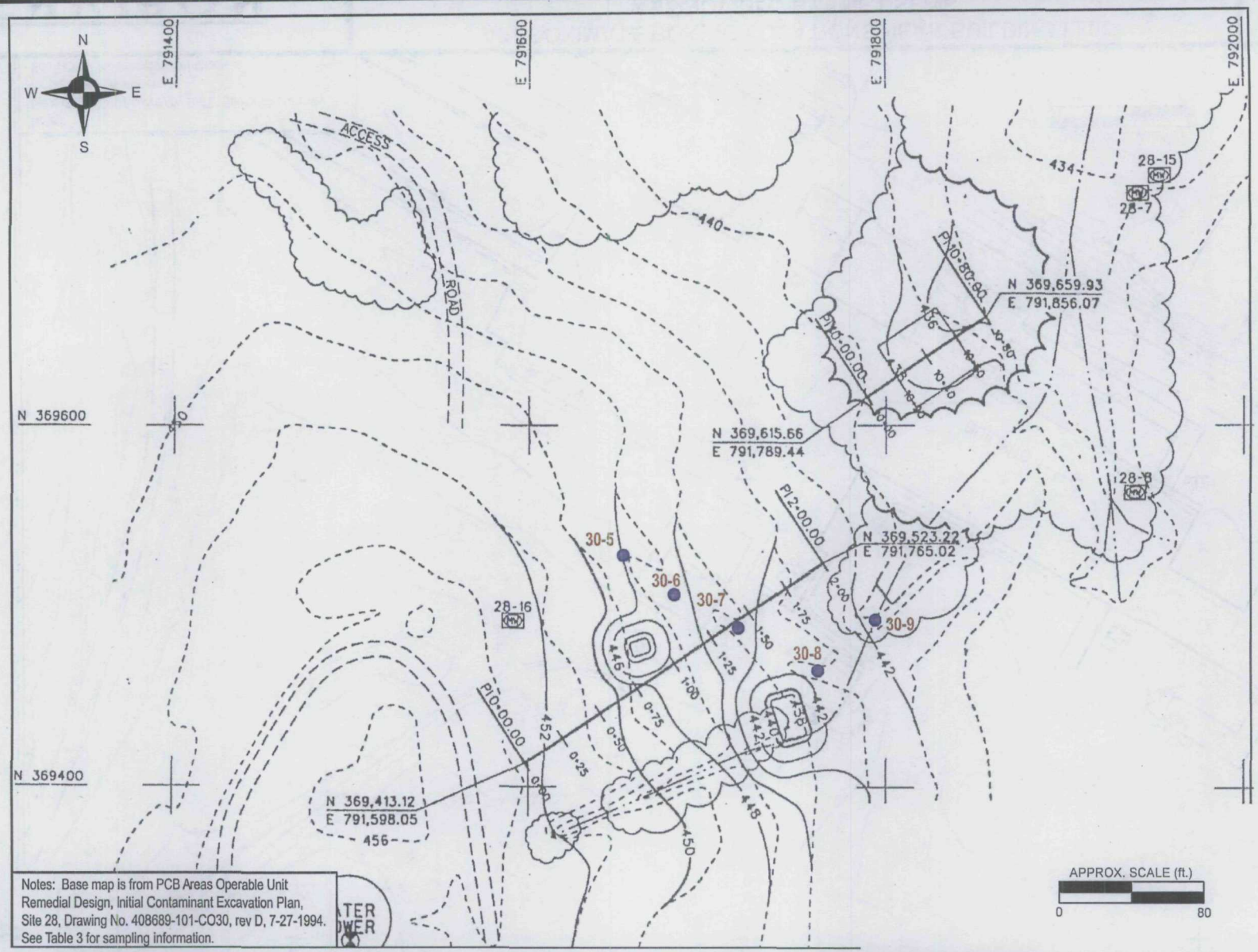
ENVIRON

APPROXIMATE BORING LOCATIONS NEAR BUILDING I□□□□
AS PROVIDED BY THE USFWS
CRAB ORCHARD
MARION, ILIINOIS

Figure
1

Drafter:	ELS	Date:	8/27/10	Contract Number:	07-24847A	Approved:	BSK	Revised:

L:\Loop Project Files\00_CAD FILES\07\Crab Orchard 07208876 (A-D)\Aug 2010\01_Approx. Boring Locations Near Bldg I-1-□.dwg



ENVIRON

APPROXIMATE BORING LOCATIONS AT SITE 28
AS PROVIDED BY THE USFWS
CRAB ORCHARD
MARION, ILIINOIS

Figure
2

Drafter:	ELS	Date:	8/27/10	Contract Number:	07-24847A	Approved:	BSK	Revised:

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EXHIBIT 5

East and West Swale Sediment Basin Construction[1]
Crab Orchard National Wildlife Refuge (CONWR)
May, 2008

Purpose and Objectives

Schlumberger and FWS are proposing to evaluate, design, and implement additional site improvements to facilitate long-term management of the potential for migration and transport of residual PCB solids across the site due to soil erosion by surface water runoff. Important issues associated with the site are the potential for soil erosion and instability of the upland soils. This conclusion is supported by the results of the FWS samples, which tend to indicate that PCB residuals associated with transport of PCB solids selectively accumulated in low-lying swale and surface depression depositional areas since completion of the remedial action fieldwork in 1997. In addition, regardless of chemical concentrations, sediment transport to Crab Orchard Lake can also have adverse ecological effects on biological communities. The physical stability of the site, with respect to the transport and/or migration of soil and possibly other materials impacted by PCB residuals, is a key factor in controlling the long-term risks associated with the site. It will be important to manage the transport of soil particles that may potentially be impacted by PCB residuals across the site via erosion and surface water runoff flow. The site improvements proposed in this section will complement the removal actions that have been conducted at the site and will further enhance site protectiveness.

The proposed control measure, which could be readily accommodated by the existing site topography in two of the primary "local drainage basins," i.e., the East Swale and the West Swale, is the construction of a surge control/sedimentation basin located within each swale approximately midway between the building complex and the lake. These basins would effectively contribute to the objective of stabilizing and controlling PCB residuals on the site, by providing the following:

- A "hold-up" volume for surface runoff of sufficient size to accumulate the peak flow volume from storm events of higher intensity (e.g., up to an approximate 25-year storm event), and from lesser-intensity storm events, without backing up water within the drainage reach into site areas that would interfere with normal facility operations. This would function to greatly reduce the peak runoff flow velocities in the drainage swales from the outlet of the basins to the lake, thereby helping control erosion.

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[1] This work plan for the east and west swale sediment basin construction was submitted to and reviewed by the USFWS. The plan was implemented in 2009 in conjunction with the Five Year Review removals conducted by RMT, Inc.

- A sufficient storage volume and hydraulic detention time for surface runoff at a selected location, to facilitate the removal of suspended solids containing PCB residuals by providing a design for the basins that promotes solids sedimentation/filtration without the use of water treatment chemicals or equipment. The basins would provide a secondary level of control of PCB migration, where PCB-solids would be removed from surface runoff flow and allowed to accumulate, thereby preventing the PCBs from potentially being transported farther toward, or possibly into, Crab Orchard Lake. The basins would be designed to facilitate periodic removal and appropriate disposal of accumulated solids within the basins, which may be required to maintain PCB concentrations in the surface soil zone within the basins at protective levels and for general maintenance purposes.

FWS and Schlumberger jointly determined that a sedimentation basin in the Center Swale would not be necessary since the Center Swale already has a natural sediment trap/basin immediately upgradient of the Repository. However, a storm water retrofit has been developed for this area of the Center Swale (See Work Plan 2). This natural area serves to accumulate some sediments and has abundant aquatic and terrestrial wildlife and as such, the potential habitat injury associated with physical disturbance of this area would outweigh any benefit associated with construction of a sedimentation basin in this area.

Design Objectives, Approach, and Basis

Design Objectives

The proposed sedimentation basins are intended to intercept surface water runoff from the local catchment areas that drain into the East and West Swales, to accomplish the following design objectives:

- Dampen and control the peak runoff flowrates in the swales and to the lake downstream of the sedimentation basins, to reduce erosion and potential transport of soil particles into the lake embayments by improving conditions for maintaining vegetation in the swales and by reducing water flow velocities.
- Provide facilities to promote the settling and removal of soil particles that may have PCBs, and other settleable solids conveyed by flowing surface water runoff, to minimize the potential transport of PCB-impacted solids into the lower sections of the East and West Swales and into the lake embayments.
- Provide specific locations for accumulation of potential PCB-impacted soil solids that may be transported toward Crab Orchard Lake via surface water runoff, to facilitate periodic maintenance for management of the accumulated material.

Preliminary Design Approach

The HydroCAD® computer program (HydroCAD Software Solutions LLC, Chocorua, New Hampshire, 2006) was used with digital topographic contour maps (1-foot contour interval) of the overall site, made from aerial photographs taken in February 2001, to estimate the extent of the catchment areas that direct runoff flow into the East and West Swales (Figure 6-1) and to estimate the peak surface water runoff flowrate and volume expected in each catchment area from a design storm event.

Water surface area is the critical factor when designing sedimentation basins for settling efficiency. The ratio of the water surface area at the maximum desired water elevation within each basin to the peak water flowrate through each basin was selected to be able to remove (settle) a selected minimum size of soil particle in the basins. For an ideal sedimentation basin, particles with settling velocities greater than the critical settling velocity will be removed. Increasing the water surface area or decreasing the water outflow rate from the basins will increase the settleable solids removal efficiency. Increasing the basin depth reduces the potential for bottom scour and re-suspension of settled solids, and provides a volume allowance within the basins for accumulation of settled solids between cleaning events.

The basins will be designed as "dry type" sedimentation or detention basins, rather than "wet type" design. With the dry type design, the basins will be normally dry, to deter attractiveness of the basins to waterfowl and to make the full storage volume of the basins normally available to accommodate the design storm event. The outlet structures will be designed to allow the accumulated water pool to slowly drain-down during and following each storm/runoff event, with the flow continuing to Crab Orchard Lake. With the wet type design, a water pool is normally present in the basin, and the flow exits the basin only by means of a high-level overflow structure/weir, outlet pipe, etc. The wet type design does not typically provide the amount of surge flow dampening that is provided by the dry type design.

Design Basis

The key design parameters and assumptions for the sedimentation basins are summarized in Table 6-1.

Preliminary Configuration and Function

The conceptual layouts for the sedimentation basins to be constructed in the West and East Swales are shown on Figures 6-2 and 6-3, respectively. As noted above, the existing topography in both the West and East Swales at the locations selected for the basins can be relatively easily modified to accommodate the proposed construction, including existing access roads with culvert pipes that would be modified to form the downstream or outlet end of the basins.

A preliminary conceptual design for the outlet structure that would be constructed in each basin is shown on Figures 6-4 and 6-5. During rainfall or snow melt events, surface runoff within the catchment area of each basin will flow into the basin and begin to pool. The rate of increase in depth and volume in the basin, as well as the amount of suspended soil solids and general debris in the runoff, will depend on the storm intensity and duration, and ground surface conditions, particularly surface soil moisture content and seasonal changes in vegetation. As water accumulates in the basin, it will begin to exit the basin through the underdrain pipe "filter" as well as through holes in the vertical outlet (riser pipe or concrete structure) (Figure 6-4). If the water level rises to the top of the vertical outlet, it will begin to overflow into the outlet pipe/structure at a high rate. If the water level continues to rise beyond the flow capacity of the vertical outlet pipe/structure, a high-level spillway in the berm near the vertical outlet structure (Figure 6-5) will allow the peak flow to be discharged from the basin into the downstream section of the swale in a controlled manner, to prevent overtopping of, and potential erosion damage to, the berm. As noted in Table 6-1, the basins will be designed to retain the full runoff volume from a 25-year, 24-hour storm event, without overflowing into the top of the vertical outlet riser/structure, with the basin dry prior to the storm event.

As the incoming runoff flow subsides, the quiescent conditions in the basin will allow settleable solids to be removed in the basin as the water continues to slowly drain from the basin through the holes in the vertical outlet pipe/structure and through the underdrain pipe.

Estimated Maintenance Requirements

As intended, settled solids and general vegetation debris will accumulate in the basins over time. An estimate of the rate of solids buildup in the basins was prepared using two reference sources (USEPA, 2004)(Wisconsin DOC, 2008). Both reference sources provide calculated solids buildup rates based on input factors such as basin surface area; annual average precipitation generating runoff; basin floor slope and length; catchment area runoff coefficient; soil erodibility; type of land cover; etc. Using comparable input parameters with both reference

sources, a similar projected solids accumulation rate of approximately 0.25 inch per year was obtained.

A typical recommendation for maintenance of sedimentation basins is that accumulated solids be removed when the solids depth is approximately 2 inches. Using an estimate of the bottom surface area in each basin where the solids would accumulate, with the estimated accumulation rate of 0.25 inch per year, the approximate cleanout frequency for each basin would be every 8 years. The most appropriate cleanout frequency should be determined based on actual operating experience and results. The estimated volume of accumulated soil solids to be removed during cleanout events that would occur every 8 years is approximately 120 cy for the East Swale Basin, and 30 cy for the West Swale Basin. Due to the potential presence of detectable concentrations of PCBs in the removed solids, which should be confirmed by characterization sampling, it is likely that the material would require disposal at an off-site facility licensed to receive non-hazardous bulk PCB waste material.

In addition to removal of accumulated soil solids approximately every 8 years, the following regular maintenance activities should be considered:

- Regular quarterly inspection of the general condition of the earthwork and outlet/overflow structure in the basins, and additional inspections following significant storm events.
- Semiannual removal of miscellaneous debris, including brush, tree limbs, litter, etc.
- Following each solids removal event, ground surface preparation/grading, reseeding, fertilizing, placing of mulch-mat, and riprap repair.
- Semiannual mowing of vegetation in the basins.

Table 6-1
Preliminary Basis of Design for West and East Swale Sedimentation Basins

DESIGN CRITERIA	VALUE OR ASSUMPTION
pe of basin	Dr detention t pe
Pea design storm event	2 - ear, 24-hour
Catchment/Drainage area:	
▪ est Swale	10 acres
▪ East Swale	61 acres
Average annual runoff plus recharge in catchment/drainage area:	
▪ est Swale	428, 00 cu. ft.
▪ East Swale	2,612, 00 cu. ft
Pea runoff flowrate entering basins:	
▪ est Swale	16. cfs
▪ East Swale	6 .4 cfs
Minimum particle si e to be removed	0.01 mm (1 microns) (medium to fine silt)
Maximum surface overflow rate to remove 1 micron particle at medium to fine silt solids densit	2,000 s . ft. per cfs (oldman, et al., 1 86)
Length-to-width ratio	Minimum 2:1, preferabl :1
Basin water depth	ft., to top of outlet riser pipe/structure
Effective settling area (approximate):	
▪ est Swale	0.7 acres
▪ East Swale	.0 acres

LEGEND

- CATCHMENT AREA FOR PROPOSED EAST SWALE BASIN
- CATCHMENT AREA FOR PROPOSED WEST SWALE BASIN
- PROPOSED SEDIMENTATION BASIN

AREA 9 SUB-BASINS

- BASIN 1a
- BASIN 1b
- BASIN 2a1
- BASIN 2a2
- BASIN 2b
- BASIN 3a
- BASIN 3b

NOTES

1. TOPOGRAPHIC CONTOURS (ONE -FOOT INTERVAL) ARE FROM AERIAL PHOTOGRAPHS TAKEN ON FEBRUARY 28, 2001.

0 400 800 FEET

1 " EQUALS 400 '
1:4,800

WORKING COPY

PROJECT:	CRAB ORCHARD NWR - PCB O.U. MARION, ILLINOIS
SHEET TITLE:	PROPOSED SEDIMENT BASINS WITH ASSOCIATED CATCHMENT AREAS

DRAWN BY:	PAPEZ J	SCALE:		PROJ. NO.	00-004781.17
CHECKED BY:			AS NOTED	FILE NO.	47811708_11X17.mxd
APPROVED BY:		DATE PRINTED:		FIGURE 6-1	
DATE:	APRIL 2008		4/14/2008		

RMT
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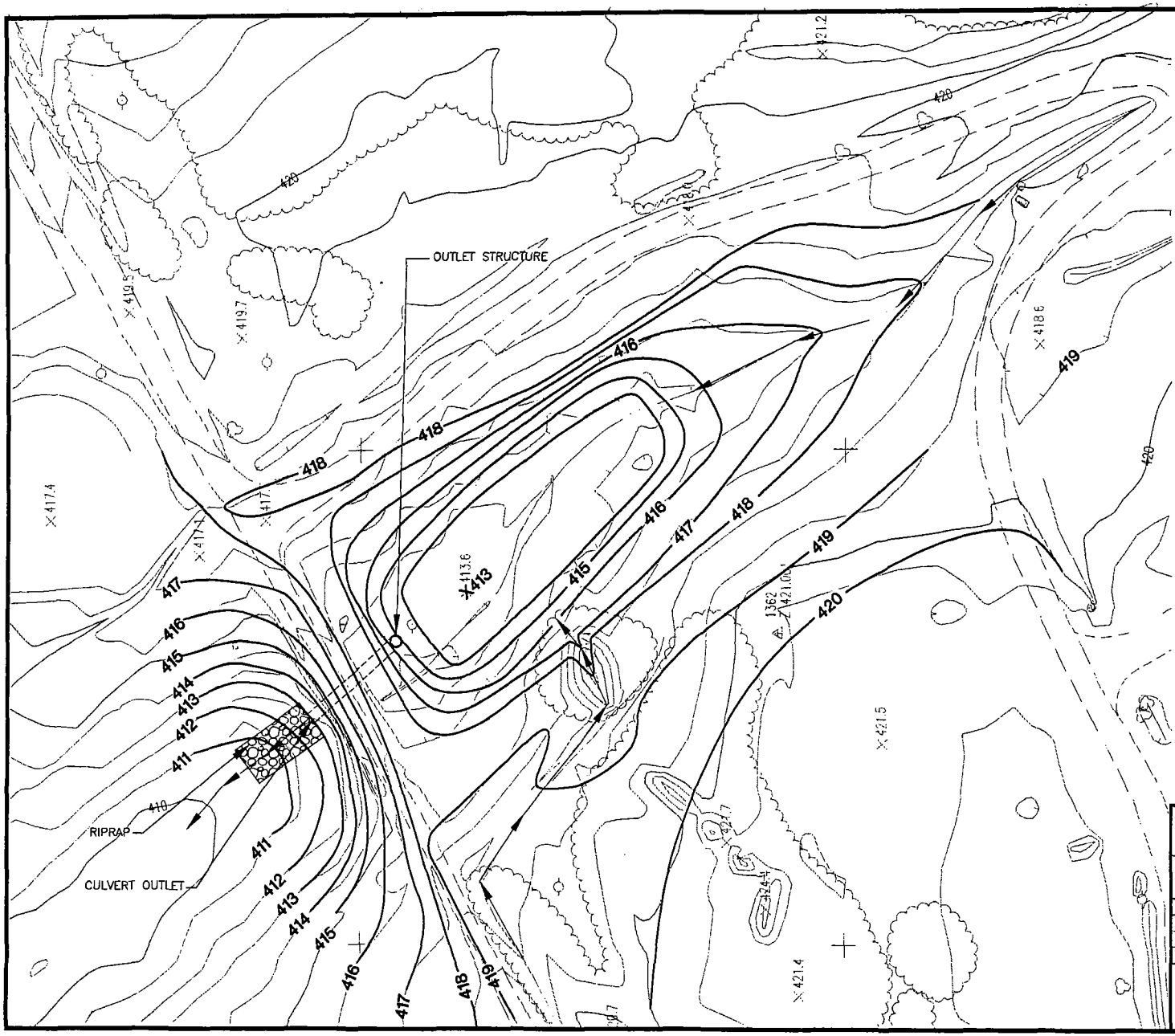
D:\04781\17\GIS\47811708_11X17.mxd 4/14/2008 13:23:49



PROJECT:
CRAB ORCHARD NWR - PCB O.U.
MARION, ILLINOIS

SHEET TITLE:
CONCEPTUAL WEST SWALE SEDIMENTATION BASIN

DRAWN BY: VELTET	SCALE:	PROJ. NO.	4781.17
CHECKED BY:	1"=50'	FILE NO.	47811705.DWG
APPROVED BY:	DATE PRINTED:	**FIGURE 8-2**	
DATE: APRIL 2008			

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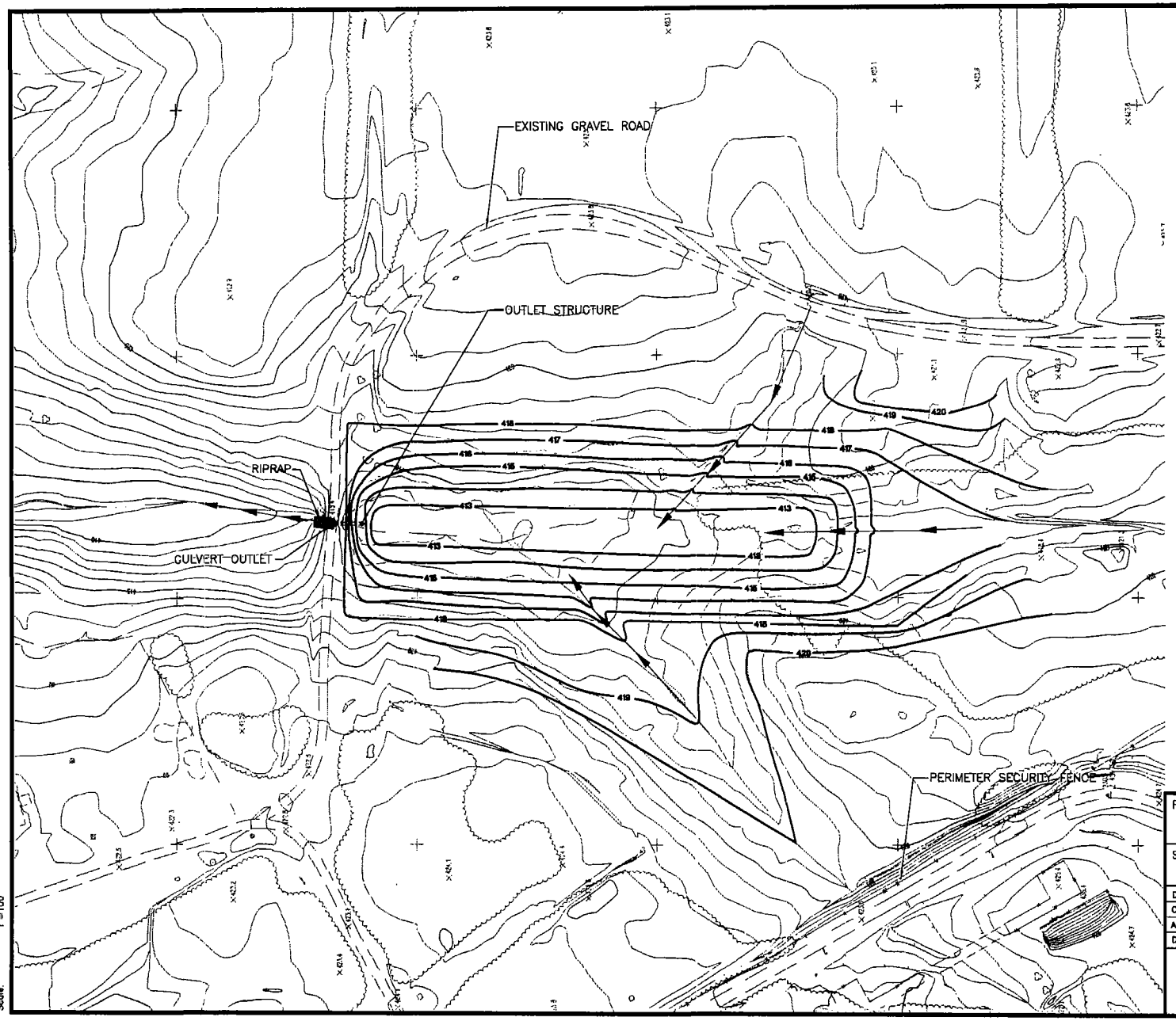
PLOT DATA
Drawing Name: J:\04781\17\CONTOURS0104.dwg
Operator Name: veltet
Scale: 1"=50'



0 100 200

SCALE: 1"=100'

PROJECT:
CRAB ORCHARD NWR - PCB O.U.
MARION, ILLINOIS

SHEET TITLE:
CONCEPTUAL EAST SWALE SEDIMENTATION BASIN

DRAWN BY: VELTET	SCALE:	PROJ. NO.	4781.17
CHECKED BY:	1"=100'	FILE NO.	47811706.DWG
APPROVED BY:	DATE PRINTED:	**FIGURE 6-3**	
DATE: APRIL 2008			

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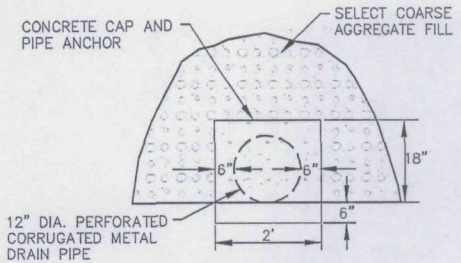
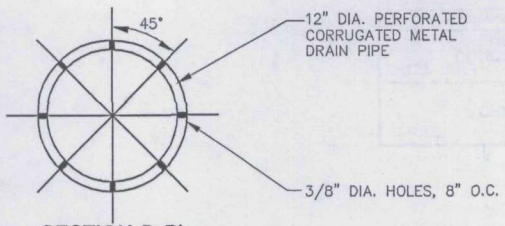
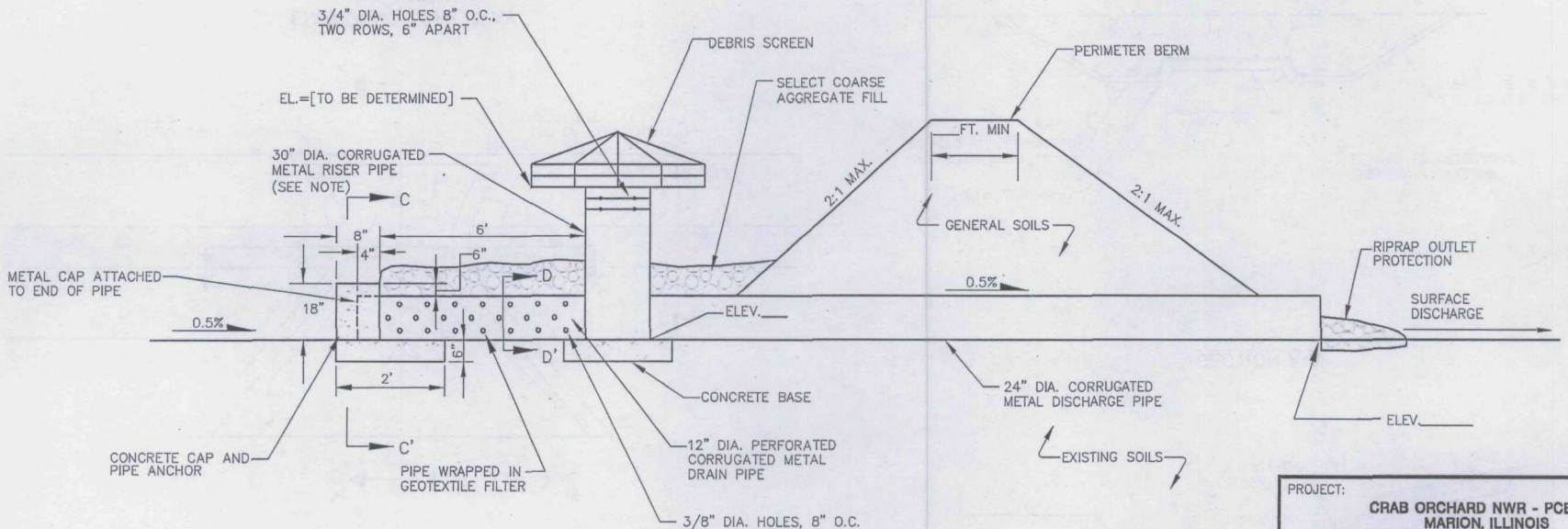
PLOT DATA
Drawing Name: J:\047811\17\47811706.dwg
Operator Name: veltet
Scale: 1"=100'



SECTION C-C'



SECTION D-D'



RISER/DISCHARGE PIPE CROSS SECTION (TYPICAL)

NOTE: CONCRETE CONSTRUCTION FOR OUTLET STRUCTURE WILL BE EVALUATED AS A DESIGN OPTION.

PROJECT:
CRAB ORCHARD NWR - PCB O.U.
MARION, ILLINOIS

SHEET TITLE:
CONCEPTUAL SEDIMENTATION BASINS OUTLET STRUCTURE DETAILS

DRAWN BY: STORMERL	SCALE:	PROJ. NO.	4781.17
CHECKED BY:	AS SHOWN	FILE NO.	DETAIL2.DWG
APPROVED BY:	DATE PRINTED:	**FIGURE 6-4**	
DATE: APRIL 2008			

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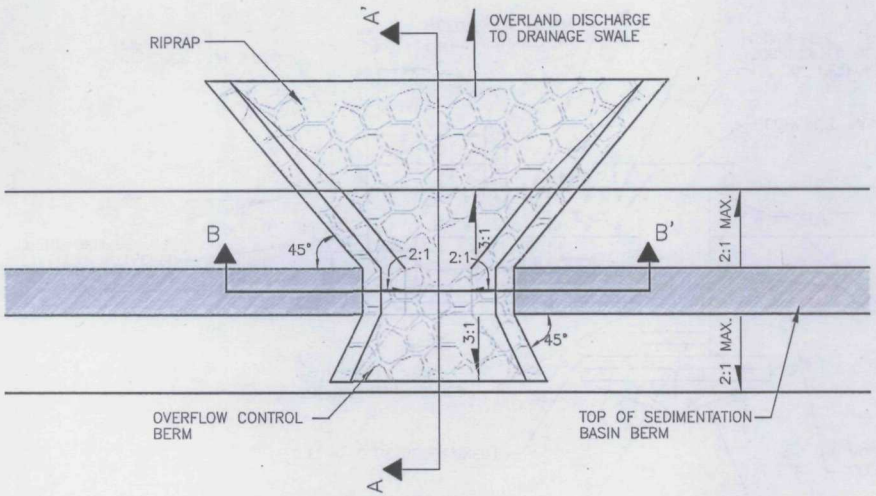
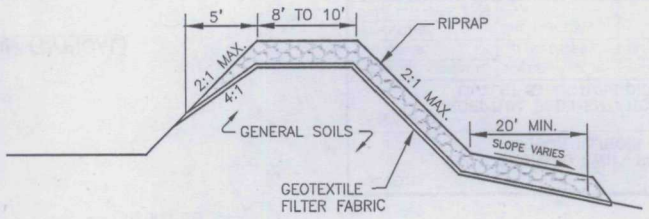
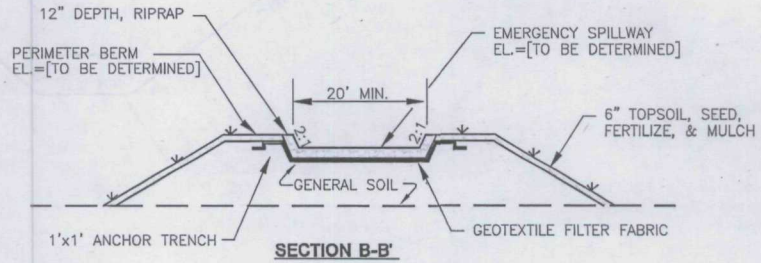
PLOT DATA
Drawing Name: J:\04781\17\Detail2.dwg
Operator Name: stormerl
Scale: 1"=1'



EMERGENCY SPILLWAY
PLAN VIEW



SECTION A-A'



SECTION B-B'

EMERGENCY SPILLWAY

PLOT DATA
Drawing Name: J:\04781\17\Detail1.dwg
Operator Name: stormerl
Scale: 1"=1'

PROJECT: CRAB ORCHARD NWR - PCB O.U. MARION, ILLINOIS		
SHEET TITLE: CONCEPTUAL SEDIMENTATION BASINS EMERGENCY SPILLWAY DETAILS		
DRAWN BY: STORMERL	SCALE: AS SHOWN	PROJ. NO. 4781.17
CHECKED BY:		FILE NO. DETAIL1.DWG
APPROVED BY:	DATE PRINTED:	FIGURE 6-5
DATE: APRIL 2008		

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